Engineering News

VOLUME 73 JUNE 10, 1915 NUMBER 23

Sewage-Works of Morristown

By Clyde Potts*

The following notes describe the design and operation of a 1,000,000-gal. sewage-treatment plant at Morristown, N. J. The plant consists of one-story settling tanks, contact beds and intermittent sand filters.

Morristown is a suburb of New York City and had a population of 12,507 in 1910. Although it is a wealthy town and has had a public water-supply since 1803, it had no public sewerage system until sewers and the sewage-treatment plant to be described were put in operation on Sept. 1, 1910, after a decade of agitation and litigation.

The location of the plant in the adjoining township of Hanover in spite of opposition, and the discharge of the treated sewage into the Whippany River, made it desirable to provide for a high degree of treatment. Analyses given later show that this has been attained. The operation of the plant has not been the subject of complaint from any adjoinin property owner.

Fig. 1. General View of Contact Beds and Sand Filters, Morristown Sewage-Works
(Automatic dosing-control house in center; sedimentation basin hidden by earth cover in right foreground)

The Design of the Plant

Absence of sewers and the metering of the entire water-supply of Morristown go far toward explaining the very low water consumption of 40 gal. per capita when the sewage-works were designed. It was estimated that with sewers the consumption would rise to 60 gal. A 10% allowance for leakage brought the sewage flow for an estimated population of 15,000 to 990,000 gal. a day, so the plant was designed for a daily capacity of 1,000,000 gal. The plant is elastic throughout. That is, it is built in sections so any one or more units may be thrown out of or into action at will. Fig. 1 is a general view, and Fig. 2 shows a plan and profile of the sewage-works.

Settling Tanks.—A 24-in. outfall sewer about a mile in length is carried across the Whippany River on a reinforced-concrete bridge and discharges into a receiving channel which supplies any one or all of the four covered sedimentation tanks. Each tank has a capacity of 100,000 gal., is 15x110 ft. in plan and has an average depth of 7⅔ ft. (See Fig. 3.)

Contact Beds.—Each of the five contact beds has an area of one-fourth acre and all combined form a pentagon. (See Figs. 1 and 2.) The beds are filled with 6⅓ ft. of ½- to 2-in. stone, retained by reinforced-concrete walls. To secure rapid and complete drainage the 10-in. concrete floor of each bed is covered with parallel rows of 6-in. vitrified split pipes, laid close together on edge and discharging from either side into a central concrete drainage channel. This channel is covered with rein-

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forced-concrete slabs, supported on the ends of the drain pipes. The tank effluent is applied to the top of each bed through distributing troughs. (See Fig. 1.)

Contact-Bed Control.—The control apparatus is located at the center of the beds and is housed in by a five-sided brick building which covers the inner angle of each of the five adjoining beds. This controlling apparatus is

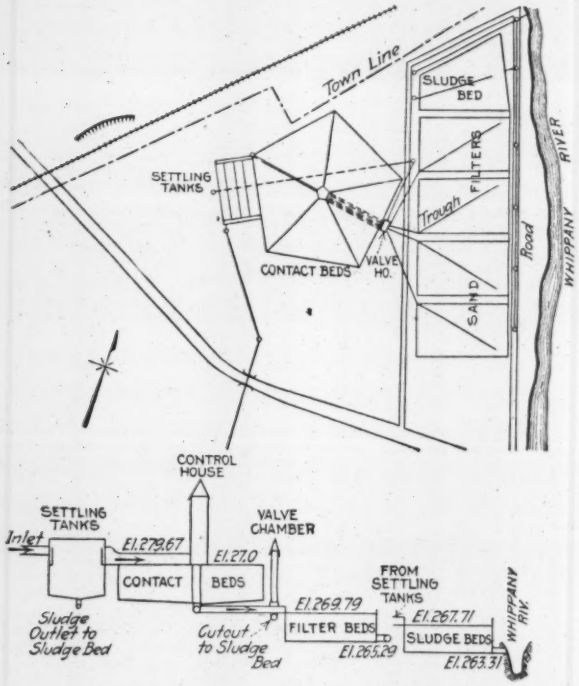


FIG. 2. GENERAL LAYOUT OF MORRISTOWN SEWAGE-WORKS

so designed that the beds may be filled to any desired depth and to stand full for any desired time. It is also arranged to permit the cutting out of any one or two of the contact beds. In the design of the plant it was anticipated that one of the beds would always remain idle.

Each of four of the contact beds is connected through a cutout chamber (Figs. 4 and 5) directly to one of the four sand-filter beds. The fifth contact bed is connected through the same cutout chamber to a fifth filter, which was designed to be used as a sludge-drying area also, and for this purpose is connected to the sludge pockets of the settling tanks. The cutout chamber is located in a small building between the contact beds and the sand filters. It is so constructed that the effluent from the contact beds can be shifted from one filter to another. It is also arranged so that the effluent of any contact bed can be discharged onto the emergency filter. This cutout chamber permits the cutting out of any sand filter while it is being worked over during the operation of the plant.

Intermittent Sand Filters.—Each of the four regular sand filters has a surface area 110x150 ft. in plan, giving a total area of an acre and a half. The beds are formed in the natural earth with side slopes of 1½ to 1. The contact-bed effluent is applied to each sand filter through a

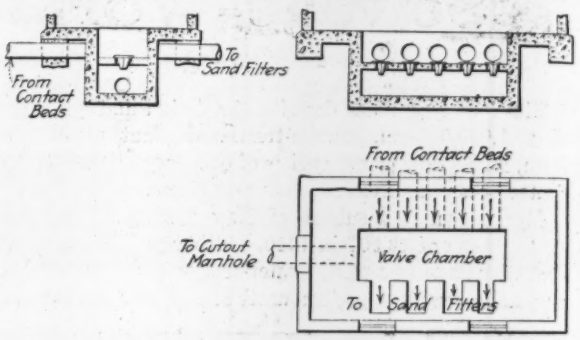


FIG. 4. DETAILS OF VALVE OR CUTOUT CHAMBER

single channel extending nearly the whole center length of the bed and diminishing in width at three double-outlet points. (See detail, Fig. 6.)

OPERATING METHODS AND RESULTS

Having the contact beds discharge through the cutout chamber directly onto the sand filters permits the latter to operate intermittently. The contact bed in this case acts as a dosing chamber. This arrangement permits the sand filters to work at their highest efficiency and has been well justified in the subsequent operation of the plant. At the present writing the contact beds work two cycles per day, on the average, and consequently the sand filters receive two doses per day of contact-effluent. This effluent, owing to the rapid discharge from the contact beds, quickly floods the surface of the sand filters. Ordinarily, within half an hour it has filtered away, and the bed is permitted to rest for some ten to twelve hours before receiving another dose. During this time it dries off and is thoroughly aërated.

A curious phenomenon in connection with this plant is noticeable immediately after the filters have become flooded. As the sewage passes downward through the sand after flooding, a multitude of air bubbles displaced by its downward passage is observable coming up and breaking through the applied sewage.

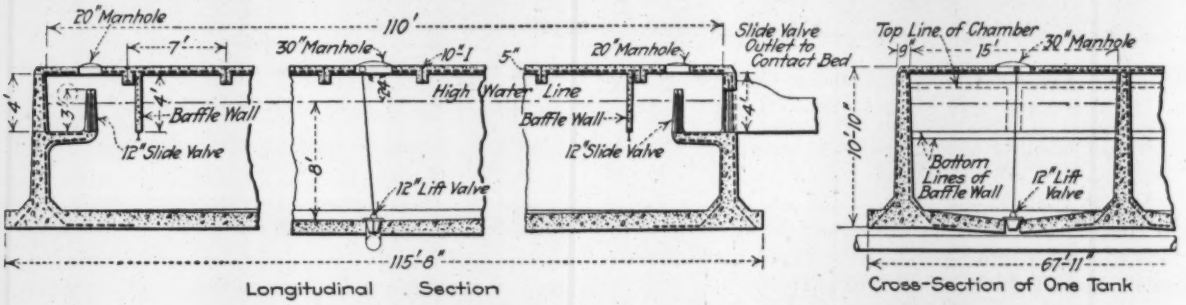


FIG. 3. SECTIONS OF SETTLING TANKS OF MORRISTOWN SEWAGE-WORKS

The surface of the sand filters is ridged before winter to prevent freezing (Fig. 7) and leveled off again early in the spring. There is apparently no appreciable difference in the quality of the effluent from summer to winter. The filters appear to operate at a somewhat lower rate in

FIG. 5. VIEW OF CUTOUT CHAMBER

(The valves may be set by hand so as to cut any sand filter out of use. Ordinarily each contact bed is directly connected with one sand filter)

the winter than in the summer, but this is largely, if not wholly, owing to the fact that they cannot be given the same attention in the winter as in the warmer weather.

The filters, while not requiring a great amount of care, do need regular attention. Any caking of the surface is broken up by the attendant, who regularly drags a small

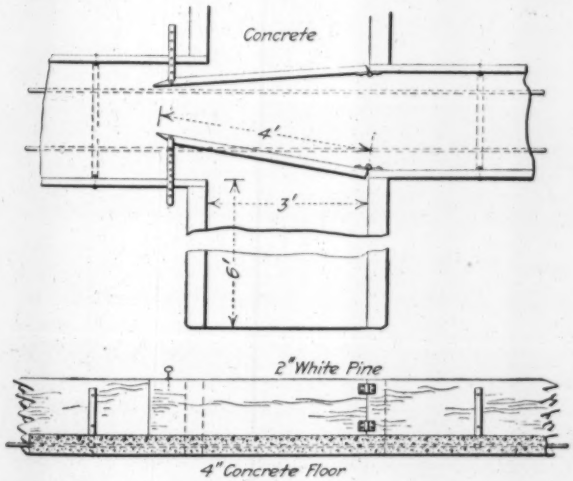


FIG. 6. DISTRIBUTING TROUGH AND GATES FOR SAND FILTER

hand cultivator over the surface. This cultivator penetrates probably two inches into the sand.

The black patches of humus which collect on the filters from time to time are gathered up and removed. Their removal is facilitated by the fact that between the doses the humus dries out and curls up, in which condition it is easily raked into a pile and removed.

Piles of fresh sand are kept available around the filters and the attendant keeps the low spots filled and the surface of the beds level.

As before stated, the settling tanks are four in number and arranged so that one or more may be used at the same time. At no time since the plant has been in operation has more than one of the tanks been in use. The scheme adopted has been about as follows:

Tank 1 was used from September, 1910, when the plant was put in operation, until the latter part of February, 1911, when it was closed off and Tank 2 put in operation. Tank 2 had been continued in operation until September, 1912, when it was closed off and Tank 3 was put in service. This scheme of operating the tanks singly

FIG. 7. RAKING SAND FILTER IN WINTER

for six months has been adhered to. There has been a noticeable tendency for the retained solids in the idle tanks to undergo decomposition for at least one year.

Only three of the units have been cleaned out since the plant was put in operation. This cleaning is accomplished by lifting the plug valve from its seat in the bottom of the tank. The contents are thereupon discharged onto the emergency filter, which is used as a sludge-drying area. This dried sludge in appearance and odor resembles garden soil. After removal from the sludge bed its only value appears to be for filling in low ground. A sample was sent to the New Jersey Agricultural Experiment Station at New Brunswick, where an examination gave the following results in pounds per hundred: Total nitro-

gen, 0.51; total phosphoric acid, 0.14; potash, 0.10; moisture (loss at 100° C.) 48.

Notwithstanding this unfavorable report of the dried sludge as a fertilizer the attendant at the plant has used it, with a mixture of lime, as a fertilizer on the ground about the plant, and with splendid results. Experiments are now being made with a mixture of sludge and ground phosphate rock as a fertilizer.

Between ten and eleven thousand people now make use of the sewerage system. The average flow at the plant is slightly in excess of 650,000 gal. per day. Of this about 100,000 gal. per day, or something under 4000 gal. per mile of sewer, is infiltration, leaving an estimated sewage flow of 540,000 gal., or about 50 gal. per capita.

Daily analyses were made of the raw sewage and effluent from Feb. 2 to Sept. 20, 1911, while the plant was operated by the writer. Since then the town chemist has made analyses at frequent though irregular intervals. The attendant at the plant makes daily methylene-blue tests of the effluent. These samples have invariably stood up the required 14 days plus. In the daily tests made from February to September, 1911, the average number of bacteria in the raw sewage was 1,951,000 per c.c. and the average number in the effluent, 63,250, giving an average removal of 96.8%.

The construction of the sewerage and sewage-treatment system was under the jurisdiction of the Board of Sewerage, composed of Rear-Admiral P. H. Cooper, Chairman; Eugene S. Burke, Secretary; Emil Hurtzig, Treasurer, and Charles D. M. Cole. The engineering was under the direction of the writer. The cost of the disposal plant complete was $94,889. The contractors were J. D. and H. K. Salmon, of Stanhope, N. J.

The plant at present is in charge of Theodore Denman and under the direction of Sewer Commissioner William H. Frapwell.

Curves for Strength and Deflection of Very Long Columns

The approximate integration which leads to Euler's formula for long columns is well known to be in error. The student particularly is apt to feel puzzled by the fact that this formula indicates conditions which he knows do not exist. According to Euler's formula, a long column slightly deflected should remain deflected and be in neutral equilibrium, and, furthermore, the same load should hold the column in equilibrium at various deflections. It is a matter of common experience, however, that a column loaded nearly to its buckling point has a slight deflection and holds that deflection, and that a greater load is required to produce a greater deflection. This disagreement of fact with formula often leads to a lack of faith in the Euler formula.

The fact is that the Euler formula by no means represents the actual behavior of a long column. The approximation made in deriving the formula results in its being wrong for all deflections except very minute deflections from the original straight vertical line of the column.

The correct equation of the curve assumed by a deflecting column has long been known. It can be expressed only in terms of the elliptic integrals.

The related true column formula (which for zero deflection reduces to Euler's formula) and some useful curves derived from these equations have been worked out by Ernest L. Robinson, of New York. Several of the curves are reproduced herewith. Where long rods in compression, or springs or similar structures which are true long columns, have to be dealt with, the only way in which computations concerning them can be carried out is by the use of these curves.

The differential equation of the long column is

$$\textit{radius of curvature} = \frac{EI}{Py}$$

Using the correct mathematical expression for radius of curvature, and integrating, the following expression is deduced connecting original length with load and deflection:

$$L = 2\sqrt{\frac{EI}{P}}\,\mathbf{F}\left(k, \frac{\pi}{2}\right)$$

where

$$k = \frac{\delta}{2}\sqrt{\frac{P}{EI}}$$

δ = deflection at middle of column;

$$\mathbf{F}\left(k, \frac{\pi}{2}\right) = \int_0^{\frac{\pi}{2}} \frac{d\phi}{\sqrt{1 - k^2 \sin^2 \phi}} = \text{complete } \mathbf{F} \text{ elliptic integral}$$

The shapes assumed by a steel rod 0.18 in. in diameter

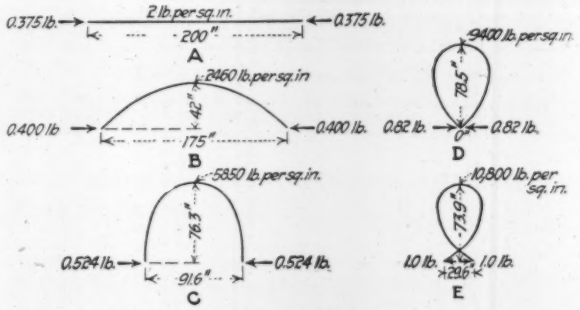


FIG. 1. A LONG COLUMN UNDER VARIOUS BUCKLING LOADS UP TO COMPLETE LOOPING

and 200 in. long, under endwise loads which range up to a load sufficient to bend it into a loop, are shown in Fig. 1 herewith.

Figs. 2A and 2B give the important general curves of the E integral and F integral, which are applicable in this problem as well as in others involving elliptical integrals.

Some of the derived curves for columns are given in Figs. 3A, 3B and 3C. Fig. 3A is of general interest because its curves represent directly the curves which would be assumed by a column fixed at the lower end and free at the upper end; the base portion of the column here corresponds to the upper horizontal part of the curve, while the lower part of the curve, at the zero point, corresponds to the loaded end of the column. Figs. 3B and 3C represent other combinations of the various values that may occur in the solution of column problems.

Some of the curves for a special problem, or rather for a column of particular size, are given in Figs. 4A, 4B and 4C and in Fig. 5. The curves of Fig. 4 are somewhat related to the immediately opposite curves of Fig. 3, with differences, however, due to the different nature of expression of the coördinates. The curves in Fig. 5 may be understood a little better if it is noted that the

curve for zero deflection is the ordinary Euler curve. In order that it should look like the ordinary Euler diagram the curve must be turned so that the vertical side is its base, in which event the ordinates will represent load and the abscissas will represent (since the radius of gyration is constant) increasing values of the length-ratio. The column represented by these curves would be, if of steel, a circular rod about 0.18 in. in diameter, or, if of wood, a stick about ¾x¼ in.

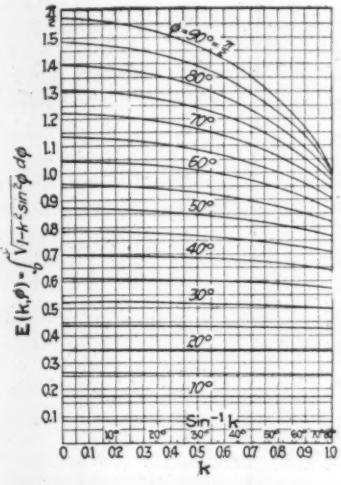


FIG. 2A, THE E ELLIPTIC INTEGRAL

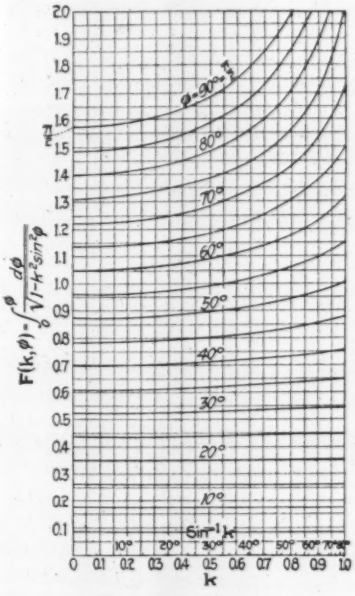


FIG. 2B, THE F ELLIPTIC INTEGRAL

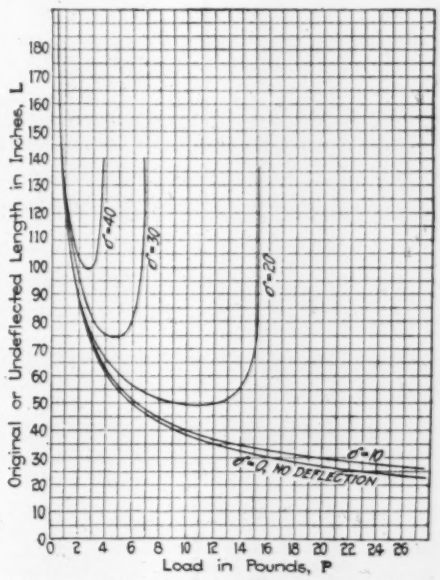


FIG. 5, CHART SHOWING RELATION BETWEEN LOAD, TRUE LENGTH, AND DEFLECTION FOR A COLUMN FOR WHICH EI = 1520 IN.²-LB.

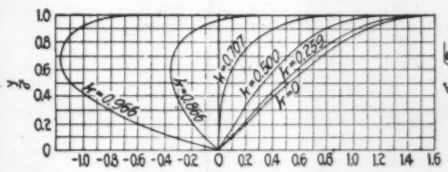


Fig. 3A, $x\sqrt{\frac{P}{EI}}$

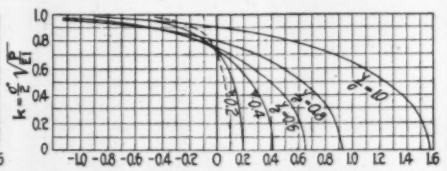


Fig. 3B, $x\sqrt{\frac{P}{EI}}$

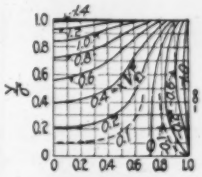


Fig. 3C, k

FIG. 3, GRAPHIC SOLUTION OF THE RECTANGULAR EQUATION OF THE CURVE ASSUMED BY A DEFLECTING COLUMN

$$x\sqrt{\frac{P}{EI}}=\left[2E(k,\tfrac{\pi}{2})-F(k,\tfrac{\pi}{2})\right]-\left[2E(k,\phi)-F(k,\phi)\right],\quad k=\frac{\delta}{2}\sqrt{\frac{P}{EI}},\quad \cos\phi=\frac{y}{\delta}$$

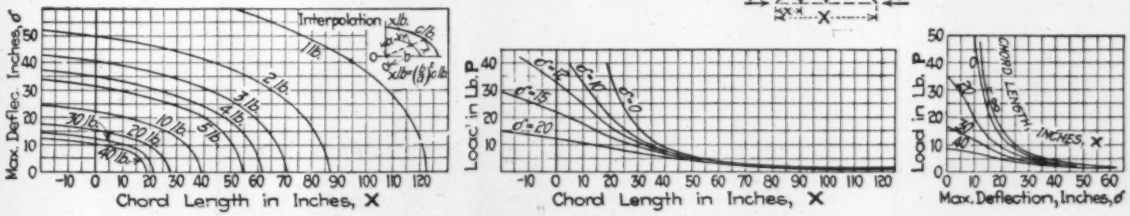


FIG. 4, CHART SHOWING RELATION BETWEEN LOAD, CHORD LENGTH, AND DEFLECTION FOR A COLUMN FOR WHICH EI=1520 IN.²-LB.

FIGS. 2 TO 5. CURVES FOR VARIOUS FACTORS IN THE DEFLECTION OF VERY LONG COLUMNS

(Plots of the elliptic integrals E and F are included. These can be applied to other problems than columns)

The Classification and Indexing of Technical Literature is proposed by an association of engineering societies. At the February meeting of the New York Section of the American Society of Mechanical Engineers, Edwin J. Prindle read a paper outlining a system for classifying and digesting the information in the Society's published "Transactions." Since the presentation of the paper the council of the society has appointed a committee on the classification of engineering literature, made up of Fred R. Low, Editor of "Power," chairman; Prof. L. P. Breckenridge of Yale University, W. W. Bird, A. E. Forstall and E. J. Prindle. On May 21 a meeting was held at the United Engineering Societies' Building of delegates from about twenty national engineering and technical societies for the purpose of forming a permanent organization for preparing a standard form of classification for the literature of applied science which could be adopted by the societies represented at the meeting and others that may be interested. A paper was read by W. P. Cutter, the librarian of the Engineering Societies' Library, describing the various classifications which have been developed for technical literature. He said that no existing classification is complete enough to be satisfactory for general adoption as standard for all the societies. A permanent organization was affected by electing Fred R. Low chairman and W. P. Cutter secretary, who, with Prof. Edgar Marburg, H. W. Peck and Prof. Samuel Sheldon, will comprise the executive committee.

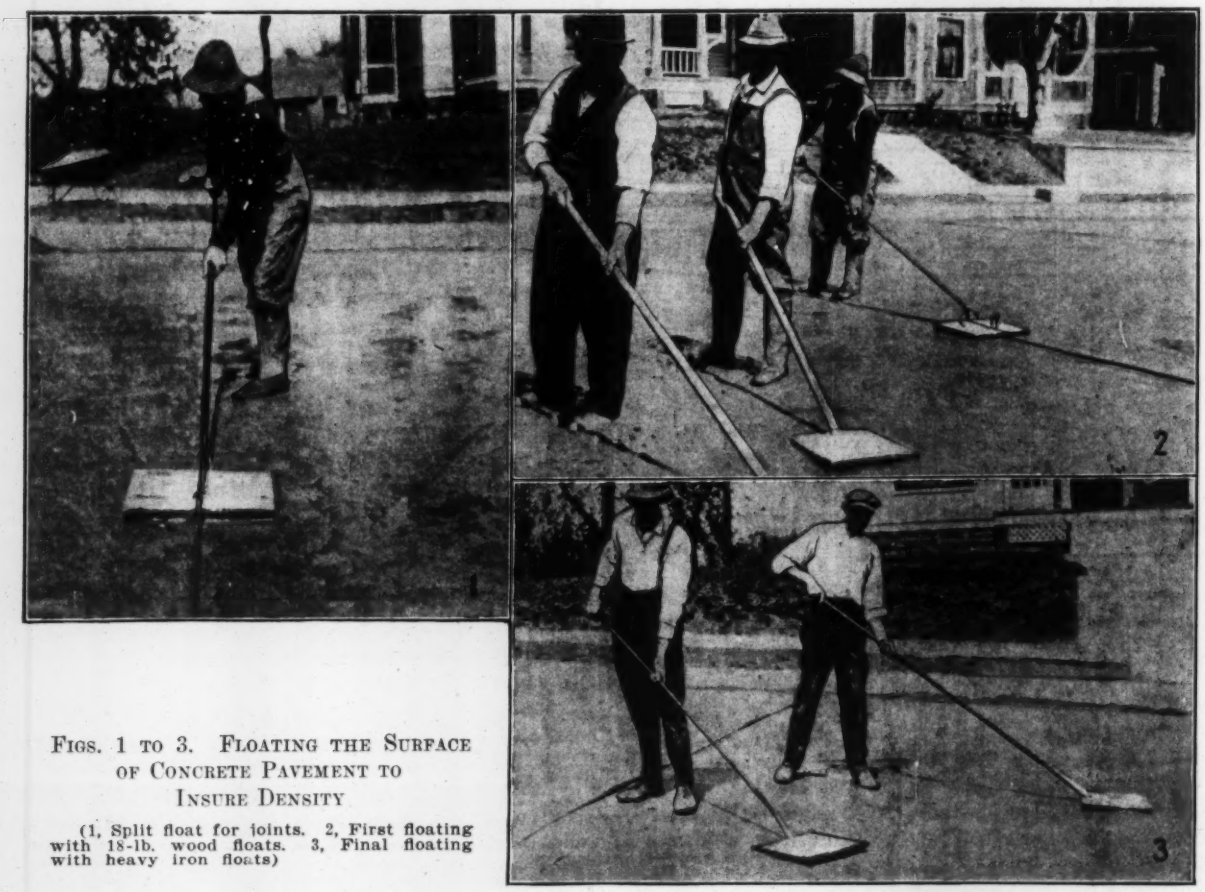
The Concrete Pavements of Sioux City, Iowa

By T. H. Johnson*

The Sioux City methods of building concrete pavements have been characterized as a radical departure from current methods and as a violation of some of the prime essentials of supposedly good practice; yet we have some of the best concrete pavements to be found anywhere. The question then naturally arises whether the superior quality of the Sioux City pavements may not be due to this same violation of current practice.

It is the purpose of the writer to show that there is such a relationship and, further, that Sioux City practice is logical and consistent, while current practice elsewhere is in many respects just the opposite. Moreover, we rather resent the accusation that we have departed from so-called standard practice, for the reason that we were building successful concrete pavements by our present method long before current "standard specifications" were thought of.

The use of concrete for street pavements develops a set of requirements entirely different from those of any other class of concrete construction. The conditions under which the concrete is mixed and placed are different. The nature of the structure itself is different. The conditions under which it must develop its service and fulfill the purpose of its existence are vastly more trying than those of any other class of concrete construction. The so-called present standard practice fails to properly take account of these differing requirements.



Figs. 1 to 3. Floating the Surface of Concrete Pavement to Insure Density

(1, Split float for joints. 2, First floating with 18-lb. wood floats. 3, Final floating with heavy iron floats)

Sioux City Practice

Briefly stated, the Sioux City practice is to lay a one-course concrete pavement 6 in. thick, on a well prepared soil foundation, using a wet mix of rather lean proportions—1 : 2½ : 4. All available means are used to secure the greatest possible density. Immediately after being placed the concrete is brought to the proper crown and leveled with shovels and then thoroughly floated with long-handled wooden floats weighing about 18 lb. each.

Following this floating, a dry mixture, one part cement and one part fine aggregate, is sprinkled over the surface in quantity sufficient to absorb all surplus water. The pavement is then floated again with still heavier floats until the added dry mixture is thoroughly wet and incorporated with the surface mortar, leaving the surface wet and slushy. This entire process of leveling, floating, placing the dry mixture and refloating is accomplished in an average of 10 to 15 min. after the placing of the concrete. A third and final floating is given as soon as sufficient set has taken place and is continued as long as the setting will permit.

Now as to the philosophy of this practice: Concrete has some very peculiar *peculiarities*. For proof, if any is required, the reader is referred to the discussions as reported in the proceedings of the 1914 "National Conference on Concrete Road Building." Some very eminent engineers participated in those discussions, and the logic

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of their theories confirms with peculiar emphasis the soundness of the Sioux City practice. A homogeneous unit-mass of the greatest possible density would seem to be absolutely essential in a pavement slab.

The slab should be homogeneous because concretes differing in richness behave differently; a lean mixture is more porous than a rich one, is slower setting and shrinks

FIG. 4. FINAL FLOATING, SHOWING FIRMNESS OF WET CONCRETE SURFACE

less in setting. These differences weigh against two-course concrete pavements.

The pavement slab should not only have the greatest possible density, but the density should be uniform throughout its entire depth. Cracking is due to expansion and contraction, and these in turn are due, we are told, more to difference in water content of the concrete than to the differences in temperature.

FALLACY OF THE TWO-COURSE CONCRETE PAVEMENT

Take, for instance, the two-course work of "current practice." The bottom course is a lean mixture and is simply leveled with a strike board without being compacted. It is consequently porous and absorptive. The top course, usually only 2 in. thick, is a rich mixture, and in finishing it is more or less compacted. Consequently, it is more dense and less absorptive than the bottom course.

After a heavy rain, when the foundation is saturated, the bottom course absorbs water and expands, while the less absorptive top course, exposed to the air and sunshine, dries out and shrinks. The result is obvious.

In winter the voids in this porous pavement fill with water, which in freezing increases its volume about 10%. The bottom course, because of its greater water content, expands more than the top course, tending to reverse the crown of the pavement. The traffic then results in longitudinal cracks. That is why these cracks develop mostly during the winter. As the warm spring weather approaches, these conditions are reversed, and it is the more rapid expansion of the top course, due to heat, that does things to the pavement.

Thus a two-course concrete pavement as usually laid is little more than a mass of inconsistencies—a pavement of good intentions, and as such should be relegated to the region where good intentions are reputed to be the favorite paving material.

REASONS FOR SIOUX CITY PRACTICE

Density is the point aimed at in our concrete pavements, and every step has for its prime object the increased density of the pavement slab. The addition of the dry mixture, at which most engineers balk, is really one of the essential features of our practice, and more than any other one thing is responsible for the good quality of our pavements. Because of its great affinity for water, this mixture not only absorbs the moisture on the surface, but withdraws a large percentage of the "free" water from the mass beneath.

To mix a cubic yard of ordinary wet concrete requires about 4 cu.ft. of water, and it is estimated that half of this quantity remains in the concrete as "free" water. This 2 cu.ft. of water, if left to escape by evaporation, would leave voids amounting to 7½% of the total volume. Among other things, these voids will fill with water and freeze during winter, and as water expands in freezing, the harmful effect on the concrete mass is obvious and the importance of density apparent. There seems to be sound reasoning in favor of waterproofing concrete pavements. If it cannot be done in any other way, it might be advisable to use an integral waterproofing compound.

The added dry mixture withdraws a large percentage of this free water, and the voids left are closed by the subsequent floating with the heavy floats. This rich mixture also counteracts the diluting and weakening effect of the dust, dirt and other impurities flushed to the top of the pavement and puts the pavement in proper condition for finishing much sooner than would otherwise be possible.

EXPANSION JOINTS

In the Sioux City pavement, transverse joints are placed every 25 ft. and longitudinal joints along the curbs. The Cary "sandwich" joint is used, and the edges

of the concrete are thoroughly "tooled" with a jointer having a small radius and short sides.

Aggregates

The coarse aggregate in our concrete is quartzite, crusher run, below 1½-in., with stone dust removed. The fine aggregate is a bank sand, well graded from fine to coarse, slightly deficient in the coarser particles, but this is remedied by the crusher-run rock. The curve of the sieve analysis of the fine aggregate is an average between the curves for fineness and coarseness of fine aggregate adopted by the Public Service Commission New York for subway construction (see Engineering News, Feb. 11, 1915).

Conclusions

Sioux City has some 30 miles of concrete pavement ranging in width from 24 to 52 ft., and averaging about 30 ft. This type of pavement is laid on grades up to 16% and with crowns up to 14 in., and yet these pavements are practically free from cracks. Not 2% of the 25-ft. sections into which the pavements are cut by transverse joints have developed cracks. During the present season Sioux City will lay 10 miles of concrete street pavement, and probably 15 miles of 16-ft. wide concrete road ways.

Cost Data

Contracts awarded so far this season have ranged in price from $1.02 to $1.14 per sq.yd., the difference being due to the varying distances the materials are to be hauled from the delivery tracks. In the case of the lower price the average haul is about two-thirds of a mile, and in that of the higher about 1½ miles.

The prices of materials on track are:

Crushed rock, $2.10 per cu.yd.

Sand, $1 per cu.yd.

Cement, $1.04 bbl.

oint material, $0.04 per sq.yd. of pavement.

Grading and preparing foundation, $0.10 per sq.yd. of pavement.

The labor cost for mixing and placing concrete and finishing pavement is about $0.12 per sq.yd.

Topographic Surveys for Logging Operations

By Earl A. Marshall*

SYNOPSIS—Topographic surveys of forest lands for developing logging operations are a refinement of timber cruising. Such surveys differ from other topographic surveys in that they cover densely wooded areas, must be cheaply done, cover large areas for large-scale maps and yet be sufficiently accurate to lay out logging railways and other works. This has given rise to a special branch of surveying, herewith described.

During the last few years contour maps have been made of many of the large timber holdings of the Pacific Northwest. Surveys have covered areas from a few thousand to over fifty thousand acres. These maps are intended for use in planning logging operations, when the timber lands are to be opened up by a system of logging railways with donkey engines to drag the logs to the railway.

The maps may also be used for immediate operations, or to aid prospective purchasers in the valuation of timber, or to guide holding companies in future purchases, as they often find it necessary to develop adjoining lands by railways to reach their own.

In using the maps the general routes of proposed railways are projected on them and the general character of the grades and alignment is determined. In conjunction with estimates of the amount of timber on the various parts of the tract the logging engineer compares the costs of various plans of logging and determines the cheapest.

In heavy-growth timber he will usually find it best to build railways close together, with a corresponding short donkey haul, but to pick up scattering timber or to reach a part of the tract where railroad development will be unusually expensive he may deem it best to put in several donkey engines in tandem, each to haul the logs in its turn. To determine the best methods of procedure without a contour map is practically impossible.

General Requirements.—The contour map must be of such a degree of accuracy that, after the approximate position of all railways has been decided upon, it is perfectly safe to go ahead and locate and build any part of the system, without surveying the rest. To do this the general topographic features must be shown correctly, but the details need not be exact. For convenience, scales of 8 or 16 in. to the mile are desirable, and the contour interval should be 50 or 25 ft.

Survey Methods

The general methods have been to run a base system of transit lines and parallel compass lines, with elevations by direct leveling, and to fill in the details by sketching from lines run with a hand compass, pacing for distance and using an aneroid barometer for elevation. These methods have been used because triangulation for a base system and stadia and planetable methods for filling in the details are impracticable in the dense timber and thick brush of the coast country. Many surveys have been made by pacing and aneroid barometer alone, but they are too inaccurate for railroad work.

Transit Lines—In an ideal system the transit lines would be run entirely around the tract and connected by cross-traverses about three miles apart. Trails and roads, however, should be utilized for traverses wherever possible. If the tract is small, containing a few square miles only, or if there is no local attraction, transit lines are unnecessary, and compass lines not more than half a mile apart in rough country and one mile in rolling country will answer.

In a rough, timbered country, many difficulties are encountered in running transit lines. In the first place, it is necessary to make about 30 set-ups a mile, many of

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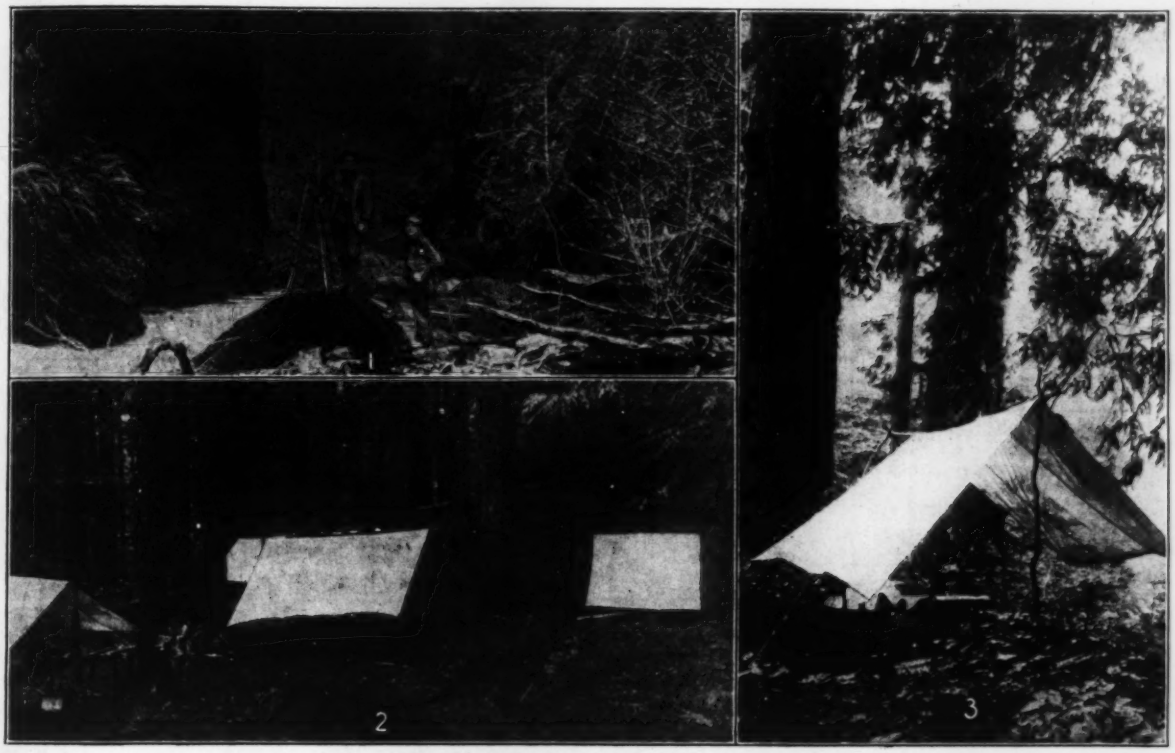
them on logs, roots of fallen trees, soft places, etc., and to turn angles at nearly every one. This is true on rough mountain trails, as well as across country.

To check his bearings the transitman should make some kind of an astronomical observation every few miles. Direct observations on the sun are, of course, the most practical. Where a clear view of the sun can be had, the ordinary method should be used of taking the mean of two observations—one, say, on the lower left-hand edges of the sun, and the other with the instrument reversed, on the upper right-hand edges. In the heavy timber this is often impossible, and the observer must take whatever edges he can see through the foliage and correct for the sun's semi-

and let them take turns at giving backsights, thereby resting a third of the time. If the brush is very thick the transitman can set up backsights and let the three chop brush. A mile is a good day's work for such a party across country, and two miles on mountain trails.

Leveling.—The transit party is followed by a level party, which takes elevations on all hubs. This leveling is done carefully, the rod being read to hundredths. Lines 15 or 20 mi. long are expected to close within a few feet.

Compass Lines.—After the transit lines have been closed parallel compass lines are run at right-angles to the transit lines, usually half a mile apart. Stakes are set on these lines every 330 ft., making 16 to the mile.



FIGS. 1 TO 3. TOPOGRAPHIC SURVEYS OF FOREST LANDS IN OREGON

(Fig. 1. In Clatsop County, Ore.; site of a present 80-ft. Howe truss railway bridge. Fig. 2. Surveyors' camp in Oregon woods; photograph taken in the rain. Fig. 3. Office tent of forest surveyors in Oregon woods)

diameter. Often it is necessary to make a special set-up in a patch of sunlight in sight of a hub, and later turn an angle out to the observation point. Several observations should be made, as a check. By using the cosine formula two or three can be computed nearly as fast as one.

Chaining.—On steep ground the work should be done by slope chaining with a long tape direct from the transit point. If the distance between hubs is greater than the tape length one slope distance can be taken forward from the transit and another backward when the transitman moves ahead. A 300-ft. tape is as long as is practicable, owing to the difficulty of lifting a longer one clear of the brush. Slope chaining is more accurate and much faster than level chaining and does away with the need of a rear chainman, as the transitman acts as such.

The Transit-Survey Party.—Where there is much brush a five-man transit party is the most economical—a transitman, a head chainman, two axmen and a rear flagman. It is often a good plan to hire three axmen

They are numbered from 1 to 16, and are called tally stakes.

The compassman is given his starting point from the transit traverse in such a way that corresponding tally-stake numbers will be directly north and south or east and west of each other, as the case may be. It is desirable to have the transit lines not more than two or three miles apart, so that a compass line will not be run too far without a closing. At each transit line a new start is made.

Considerable local attraction is often met with so that compass lines two or three miles long frequently fail to close by 50 ft. or so. The lines are drawn on the map straight from their beginning to their actual ending point, so that they are not likely to be off at any one point more than half their closing error.

An ordinary open-sight compass 4 to 6 in. in diameter, mounted on a Jacob's staff, is used. Chaining is done with a long tape and the slopes are taken by the compassman with a slope clinometer. He is furnished with a

slope reduction table, as he must reduce his distances in the field.

The line must be so well marked by blazing trees that a man looking for it will not cross it and enough brush should be cut to make way for the level party.

The compass party should tie in all government section and quarter-section corners that they are able to find in a reasonable time. Unless the brush is very thick a three-man compass party is sufficient. Anywhere from a mile to two miles of line can be run in a day.

Leveling Compass Lines.—In leveling over these lines, an error of several feet in a mile is of no consequence, as the elevations are to be used only to set aneroid barometers from. For that reason a very small level with an 8- or 10-in. telescope is used, and the rod is read to tenths only.

As most of the work is on very steep hillsides, a "shanghai" stick is used. The rodman cuts a piece of cedar about 6 ft. long, and 5 ft. up from the bottom cuts a shelf for the rod to rest on, splitting off about two-thirds of the wood from there up. This allows the rod and "shanghai" stick to lap about a foot, so that the rodman by holding them tightly together can keep the rod steady. By this means 17- or 18-ft. rod readings are possible.

Often, the rodman climbs a tree and measures down, or measures down from a high log, thereby getting 30- or 40-ft. rod readings. Even though such rough work as this is done, lines two or three miles long with a total change of elevation of several thousand feet are rarely off more than 3 or 4 ft. Even on steep ground an average of a mile a day is usually made. This takes from 100 to 120 set-ups.

Taking Topography.—As soon as the compass lines and levels have been run and platted over a part of the tract, the work of taking the topography is started. The topographer starts at a given tally stake and runs toward another half a mile away. He runs his line with a square-box compass held in his hand, paces distances and obtains elevations with an aneroid barometer.

At the tally stake, before starting out, he sets his barometer scale to correspond, or, if his elevation scale is fixed, he notes the correction. During his run he stops at least every half tally, reads his barometer, marks down the elevation, and sketches the surrounding topography.

The topographer is usually expected to cover a strip 660 or 330 ft. wide, and therefore draws the contours for 330 or 165 ft. on each side. He also sketches in creeks, trails, burns, open places, masses of rock, cabins, etc. At the end of the run he ties to the stake opposite to the one he started from, stating exactly how far he missed it for line and distance and the error of closure in elevation.

The closing errors are not as great as might be expected. For both line and distance the topographer usually comes out within 40 ft. in a half-mile run. Often he does not, but his error, whatever it is, is usually regular. Experience and care are the main requirements.

In looking over a pocket compass held in the hand, many men find it necessary to use several degrees different variation than the true. This is because they allow their stronger eye to have more effect than the weaker; in other words, if their right eye is the stronger they look to the left and *vice versa*. By trial they find out how many degrees this is.

In pacing, the topographer walks through the woods in a natural manner, counting his steps. By experience he knows how many steps he ordinarily takes in going a tally, or 330 ft. This may be 115, 124, 132 or any other number thereabouts; 125 is a standard among timber cruisers. In going up or down steep hills he must learn what allowance to make for the longer or shorter steps that he naturally takes. In going over windfalls or very steep or rough ground he can guess short distances closer than he can pace them. Many other considerations are learned by experience.

Barometric changes of over 40 ft. in a half-mile run are uncommon; oftener than not, there is no change at all.

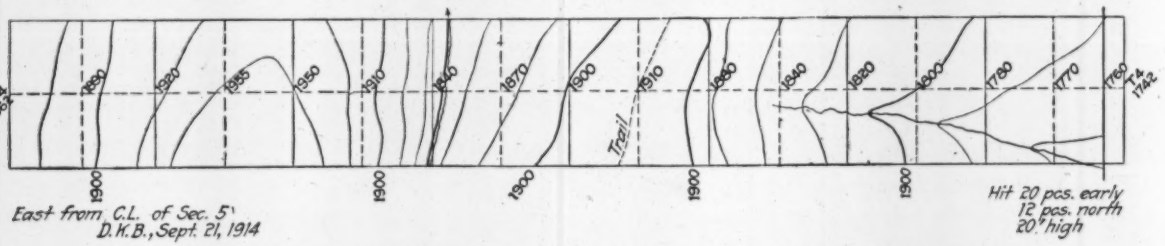


FIG. 4. SAMPLE OF TOPOGRAPHER'S NOTES; FOREST LAND SURVEYS, OREGON

At times, however, sudden and irregular changes of a hundred feet or more occur in a run, usually requiring that it be made again.

Aneroid barometers 3 in. or so in diameter costing $20 to $30 are used. Those showing 4000 or 5000 ft. are usually graduated in 10-ft. divisions, those showing higher elevations in 20-ft. divisions. Ordinarily, on the Pacific Coast, aneroids cannot be used at a higher elevation than within 1000 ft. of the limit shown. This is due to the fact that manufacturers usually place the zero of their scale in feet at a very high place on the scale of inches, so that at sea level the normal elevation read would be about 1000 ft.

The topography is sketched in cross-section books or on loose cross-section paper or, if it is raining, on celluloid pads. The sketches are turned in to a draftsman just as taken in the field. The draftsman adjusts the closing errors, usually marks the adjusted elevations on the map, interpolates for the contours, and draws them on in the same general shape as the original.

Failure of runs side by side to fit show that the work is inaccurate. This may be because of inability to see through the brush, irregular pacing or sudden barometric change. Often it is necessary to do small parts of the work over. It is customary to have topographers take alternate runs, so as to be a check on each other.

Discussion of Survey Methods.—The custom of making runs 660 ft. or 330 ft. apart is an inheritance from timber cruising, from which contour maps for logging purposes originated. For many years timber cruisers have accompanied their reports by sketches of the topography,

and many of late years have used an aneroid barometer, marking down elevations here and there and at last even attempting to draw contours.

As ownership in timbered districts of the Pacific Coast is practically always by 40-acre subdivisions, the Government surveys being by sections a mile square, the timber cruiser goes through the forty once, twice, or four times, depending on the accuracy desired. This makes his runs 1320, 660 or 330 ft. apart. He usually goes through 660 ft. apart, totaling up his timber on each 10-acre subdivision, or 660-ft. square. The first complete contour maps were made by the cruisers' assistants, called compassmen, while the cruise was being made. As methods improved and the contour work was done separately, the distance apart for making runs and many other of the old and no longer necessary methods were still retained.

It will suggest itself to the minds of many readers that it would be more economical to run lines for the topographers to work from up ridges and streams, instead of parallel and half a mile or a mile apart. In answer to this, in the first place the lines are run as described so as to keep as near as possible to Government section lines, as it is easier then both to find the corners and to tie to them. These corners are needed not only to show property lines, for a timber company rarely ever owns the whole area covered, but to place properly on the map timber estimates made at other times. (Special men should be detailed to look for corners that the compass parties have not found.) In the second place the topographers are usually men trained by timber cruisers, and endless confusion results from any attempt to make them work from irregular lines.

In British Columbia, where some contour work has been done, irregular metes and bounds surveys, often containing several thousand acres, may be encountered. Here it is best to run around the tract, so as to find its corners, and divide it up in any manner suitable to the particular case.

Maps.—After the tracings have been made in the office, it is often desirable to make a map on a reduced scale, showing the main features. This is especially needed if the tract is large, so as to get it all on one map. In a number of cases relief maps have been made also, by cutting out pieces of cardboard for each contour and nailing them together. Several coats of paint are then applied, and the creeks, section lines, proposed railways, etc., painted on. The edges of the cardboard show the contour lines.

Notes on Fieldwork

As engineers of the Northwest work in all kinds of weather, preparation for rain is as important as any other consideration. Maps are carried in tin tubes, which not only keep them dry but also clean. Transits and levels should be used that do not fog badly in the rain. When an instrument does fog, the instrumentman should not hesitate to take the lenses out of the telescope and wipe them dry. Compasses may be made rainproof by sealing up all holes with beeswax, or even with candle grease.

In the rain, notes are kept on pads consisting of sheets of celluloid bound between two pieces of heavy leather by a rivet at one corner or held together by metal rings at the top or sides. Celluloid may be ruled with a sharp-pointed knife in any manner desired. Pencil marks are not obliterated by the rain, nor is the celluloid itself affected. When the notes are copied or the topography drawn on the map the celluloid may be cleaned with an eraser or with scouring soap.

Most of this work is done far from settlements and beyond the end of wagon roads, so that it is usually necessary for the party to carry in on their backs their complete outfit—surveying instruments, camp equipment, provisions, bedding, etc. At times pack horses can be used, but there are usually no pack trails and the brush is too thick for loaded horses. Canvas pack sacks, with broad leather shoulder straps and with head straps, are used. The lightest of everything is taken, such as wool blankets, silkaline tents and flys, small axes, etc. Cooking is done in tin or aluminum buckets, and baking, in tin reflectors. Provisions are chosen that will give the most strength for the least weight.

Conclusions.—Many thousands of acres have been contoured in the manner herein described. The largest tract so far was one of 53,000 acres in Douglas and Lane Counties, Oregon, contoured last summer by the Lumbermen's Engineering Co., of Portland, Ore. The work was for the Roach Timber Co., of Muscatine, Iowa. Here 50 mi. of transit lines and about 180 mi. of compass lines were run as a base system, in addition to which a railway 14 mi. long was located to reach the tract.

The work has practically all been done by contract, at a price of 20 to 35c. per acre. Exceptional pieces of work have cost more than this, the highest price paid having been about 80c. per acre. This was done in the Cœur d'Alene Mountains, Idaho, in the deep winter snow and 18 mi. back from settlements. The highest cost to the contractor in the Columbia River country has been 34c.

Some Advice for the Novice Surveyor

The following are some extracts from the remarks of "An Old Surveyor" before the Indiana Engineering Society:

These brief remarks are designed exclusively for beginners in the business, believing as I do that old practitioners know enough to take care of themselves or to quit the business:

Be very careful to avoid mistakes at all times, but when you make a mistake (as you surely will) own it like a man and hasten to make all proper correction.

When doing field work in the presence of an old practitioner, be calm, cool and careful; do not try to convince him that you are an adept by flippantly slinging your notes down on paper without any clear idea of whether they are correct or not. This might serve to add to his amusement as a spectator, but it would not add to his desire to employ you as an assistant.

Do not fear that he will think you slow and awkward; he has traveled the same road and still feels the need of diligent care in order to avoid errors. Be diligent, careful, slow and sure, and you will get there by and by.

When in timber, or in the absence of a fence for a guide, be careful to unclamp your needle before taking your bearings.

Do not hastily condemn your instrument on a cloudy day because it does not point—as you think—north. You are more likely to get bewildered than your instrument.

Be sure to have a flagman 50 lb. heavier than yourself. If the ice bears him, you can safely venture.

If in summer you find a swamp beyond your depth, face about and wade back. That would be prudence, and not cowardice.

If you mire in quicksand, or any other treacherous substance, and find it utterly impossible to extricate yourself, call for help. Almost any patriotic citizen is willing, under such circumstances, to assist the profession by giving science a boost.

When you are given great credit for accidentally striking a corner, pocket it (the credit, not the corner), for you will surely get censure for missing one when you are not in the least to blame.

Water-Pipe Tunnel, Metropolitan Water-Works

By Beardsley Lawrence*

SYNOPSIS—A brick water-works tunnel 8½ ft. in external diameter driven through hardpan and silt in the bottom of Chelsea Creek, Boston Harbor, by use of compressed air. Construction plant and methods are described. A 42-in. cast-iron water main was laid through the tunnel and the space between the tunnel lining and the pipe was filled with concrete. A method of quickly removing the old mains from the bed of the creek is described.

A water-pipe tunnel was recently built by the Metropolitan Water and Sewerage Board to replace two 24-in. submerged pipe lines forming part of the low-service water-supply of East Boston. These pipe lines, one of which was laid in 1870 by the Boston Water-Works and the other by the Metropolitan Water-Works in 1900, crossed from Chelsea to East Boston under Chelsea Creek, a navigable arm of Boston Harbor.

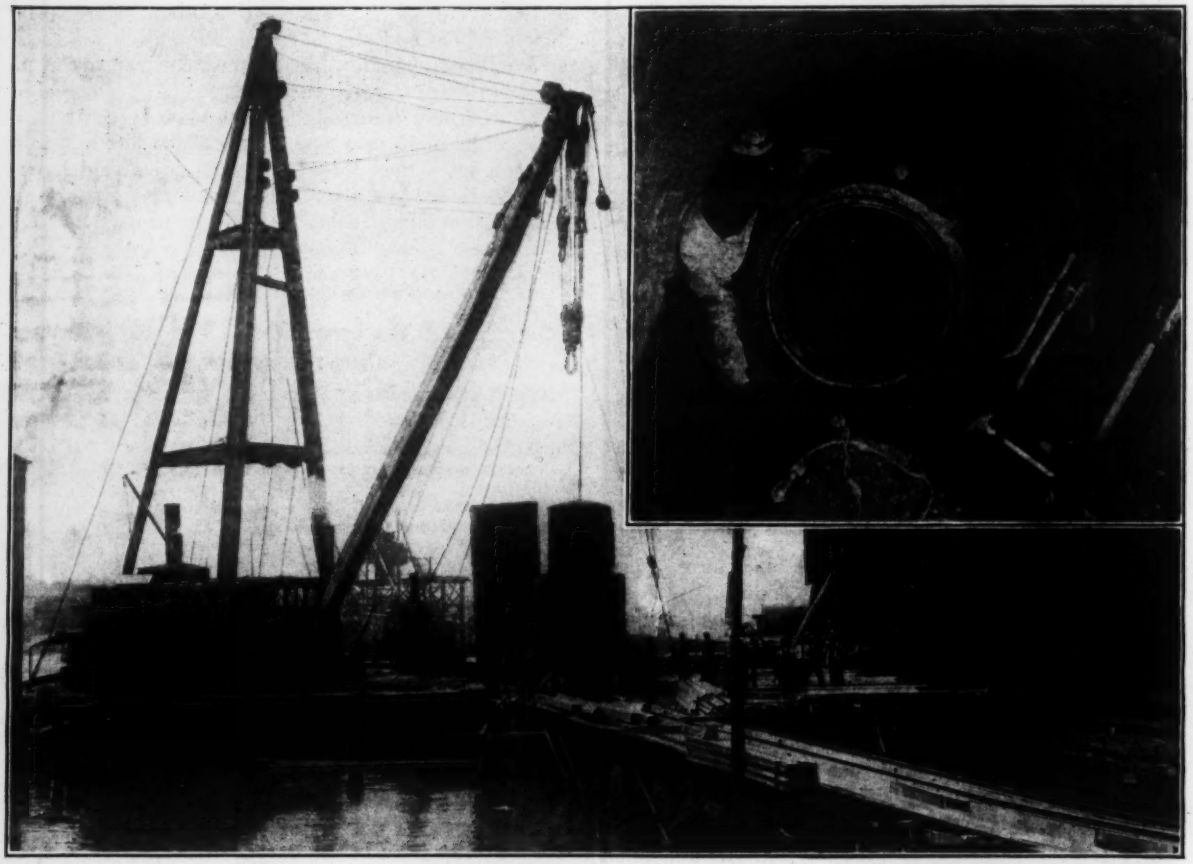


Fig. 1. Chelsea Creek Water-Main Tunnel, Boston, Mass.; Placing Air Lock on Chelsea Shaft.
Fig. 2. (Upper Corner). Filling Concrete around 42-In. Cast-Iron Main; Chelsea Creek Tunnel

The channel at this place is about 400 ft. wide, but the distance from shore to shore at high water is about 1400 ft. The old pipes were supported from both shores to the channel on pile foundations, and under the channel were laid with flexible joints. The cover over the portion under the channel was from 3 to 8 ft. Both of these pipe lines were in good condition, but were replaced by the tunnel on account of proposed dredging operations, which necessitated their removal.

General Features.—The new tunnel was built in compressed air. It is 523 ft. long between shafts, with its axis about 43.5 ft. below mean low water. The least cover over the tunnel during construction was 15 ft. One shaft is located 175 ft. from the Chelsea shore, and the other about 700 ft. from the East Boston shore, both being at about low-water line.

The tunnel is of circular cross-section, 8 ft. 6 in. in external diameter, composed of an outer shell of brickwork 8 in. thick, containing a 42-in. cast-iron pipe laid with its axis about 5 in. below that of the shell; the space between the pipe and the brickwork is filled solid with concrete mixed in the proportions of 1:2½:4. This

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form of tunnel is similar in general design to one built by the board in 1910 about half a mile farther up on the creek.

The shafts are of the same size as the tunnel, but were constructed of 12-in. brickwork instead of 8-in. The cast-iron pipe is extra heavy, being 1.8 in. thick, made with the spigot ends turned smooth, and having special lead grooves. In laying, a ½-in. space was left between the end of the spigots and the seat of the bells, to provide for the Chelsea side, a mixture of softer materials in the middle, and near the East Boston side a deep deposit of fine silty sand with pockets of gravel. This gravel caused no special difficulty in construction beyond the ordinary delays incidental to compressed-air work in this kind of material.

Construction Plant.—The plant for use during compressed-air operations was set up on the Chelsea side of the creek. The entire work was executed from this side, with

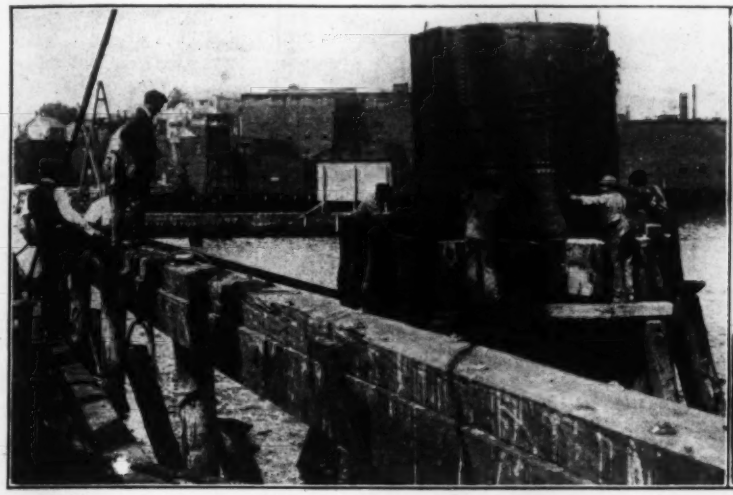


FIG. 3. CHELSEA CREEK WATER-MAIN TUNNEL, BOSTON, MASS.; PLACING STEEL-INCASED SECTION OF EAST BOSTON SHAFT

FIG. 4. PULLING UP OLD WATER MAIN FROM BED OF CHELSEA CREEK

an inside lead-wool joint in addition to the outside joint, which was made of cast lead in the usual manner.

On the Chelsea side a 36-in. cast-iron pipe, laid on a pile foundation, connects the shaft with the shore, and on the East Boston side the old 24-in. pipes are still in use to within 75 ft. of the shaft, where they are replaced by a 36-in. pipe laid on a pile trestle.

Nature of Creek Bed.—The materials underlying the creek bed were found by wash borings to be a hardpan on the exception of the work on the East Boston shaft. A temporary trestle built from the shore to the shaft was used to carry necessary piping and transport material.

The compressor plant consisted of two boilers, one of 90 and one of 75 hp., connected to two Ingersoll-Rand compressors of a combined capacity of 1400 cu.ft. of free air per min., compressed to 40 lb. This gave ample reserve capacity, the ordinary consumption varying from 300 to 600 cu.ft. per min. The maximum consumption for a

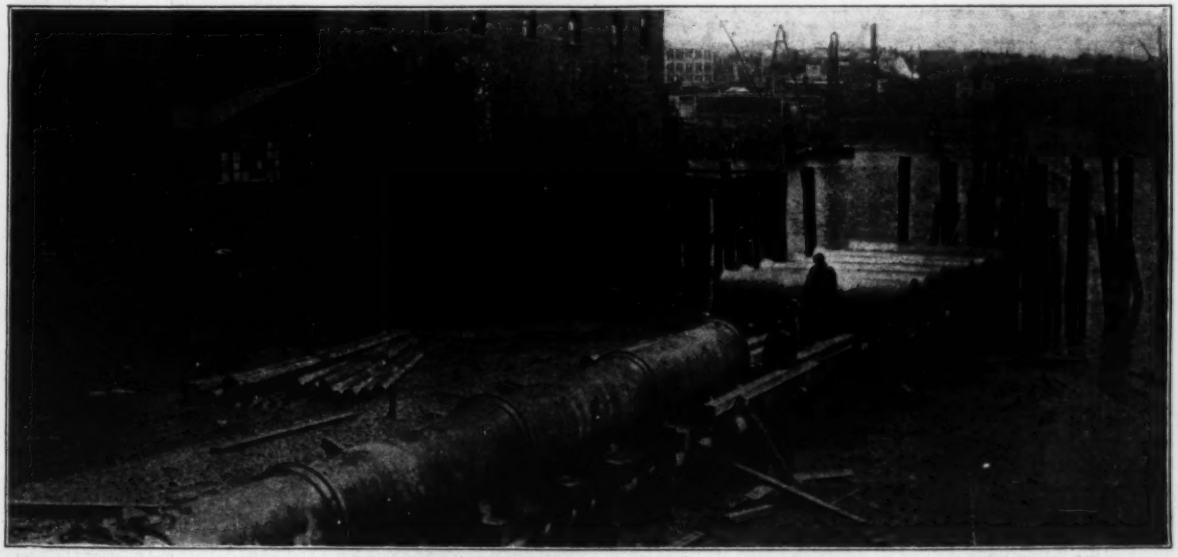
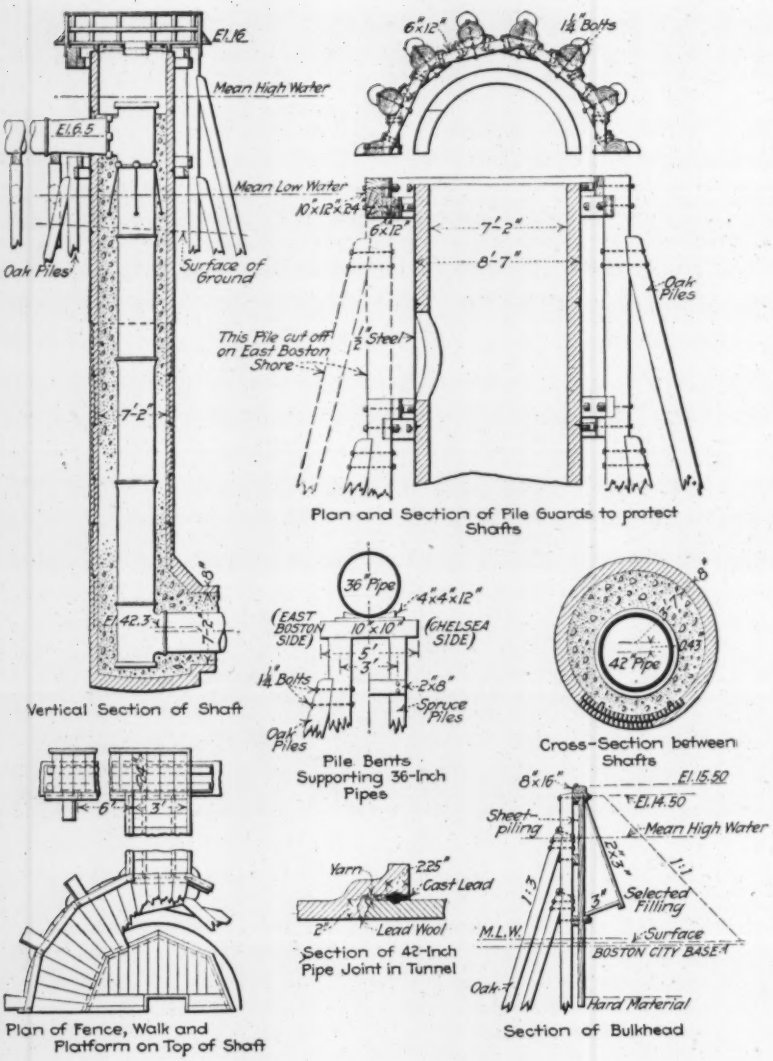


FIG. 5. LAYING 36-IN. CONNECTING MAIN; CHELSEA CREEK TUNNEL, BOSTON, MASS.



short space of time was 1120 cu.ft. per min., while the heading was in gravel.

The compressed air was cooled and cleaned by bubbling up through 4 ft. of fresh water in a vertical receiver. This water was changed frequently while the air consumption was low, and was allowed to run continually through the receiver when the volume of air required it.

The air was delivered to the shaft through a 6-in. pipe, the distance from the receiver to the shaft being about 175 ft. For about 150 ft. of this distance the supply pipe was carried as low as possible on the working trestle, allowing the water to cover it for the greater part of each tide. This tended to keep the air supply cool; the temperature in the heading varied but slightly from 65° F. during the entire period of work.

The air pressure varied from 18 to 26½ lb. per sq.in., being regulated by the engineer at the compressors, according to the tide level as shown on a float gage in the engine room. To measure air pressure, a mercury column was set up in the engine room and connected direct with the tunnel. A recording pressure gage was also used to keep a continuous record of air pressure and show any variation from the required pressure.

A small dynamo was used for lighting the tunnel, having an auxiliary connection to the street wires for use in case of accident to the plant.

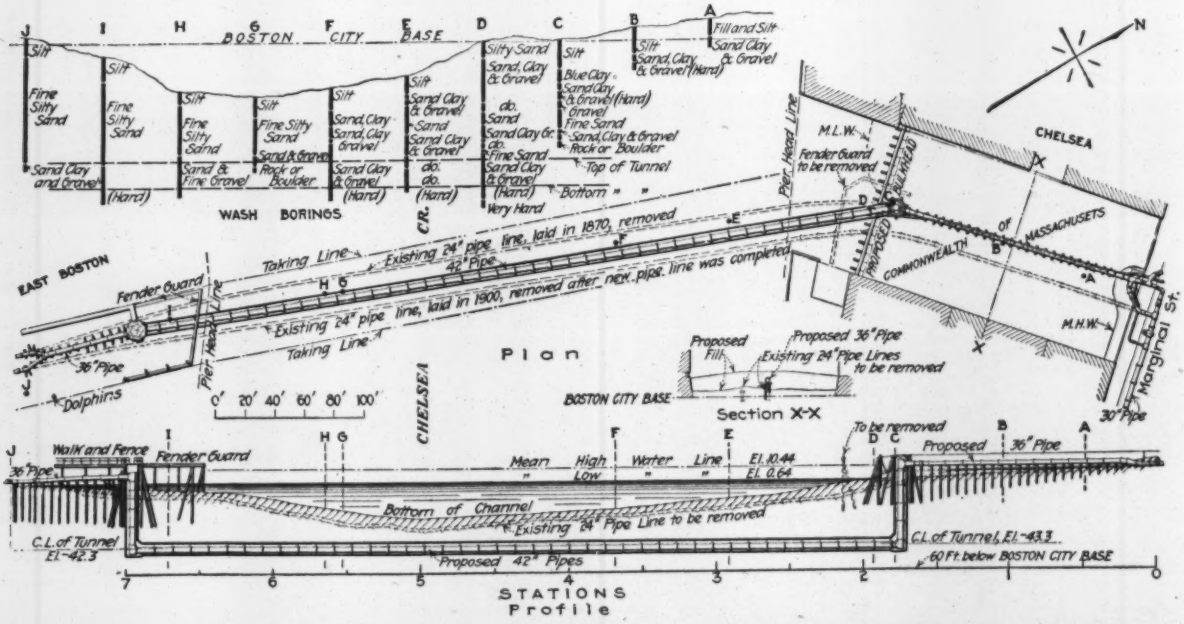


FIG. 6. PLAN, PROFILE AND DETAILS OF CHELSEA CREEK WATER-MAIN TUNNEL, METROPOLITAN WATER-WORKS, BOSTON, MASS.

A telephone connection was maintained between the tunnel heading and the engine room, together with an electric signal bell for warning the engineer before the lock was filled, to prevent a drop in pressure at the heading as the air was let into the lock.

Construction Methods.—Preparatory to sinking the shaft, circular pile guards were constructed at the location of each shaft, of the proper size to allow the shaft caissons to be sunk inside of them. The one at the East Boston side was built very strongly of 42 heavy oak piles framed with long-leaf yellow-pine lumber. This serves as a permanent protection to the shaft, its location rendering it somewhat exposed to shipping.

The guard at the Chelsea shaft was of lighter construction, being used merely as a convenience in handling the shaft caisson. When completed this shaft was surrounded by an earth fill behind a wooden bulkhead about 12 ft.

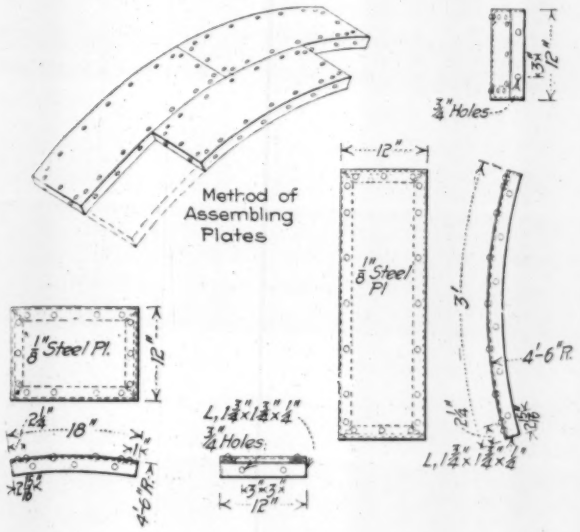


FIG. 7. DETAILS OF TUNNEL PLATES

in front of the shaft. Working platforms on piles were built around the shaft guards to support locker rooms and hoisting engines and to store materials.

The upper 27 ft. of the shafts consist of steel cylinders 8 ft. 7 in. in diameter of ½-in. plate, lined with 8 in. of brick. These cylinders were built in sections 6 and 9 ft. in length. The sections were set up and bolted together on a nearby wharf and lined with brick. The top section of each shaft was left unlined and was not bolted to the other sections until they were placed in the shaft guards.

When ready to be placed, the East Boston cylinder was 21 ft. long and weighed 29 tons, and the Chelsea cylinder was 18 ft. long and weighed 24 tons. The cylinders were brought to the work and placed in the shaft guards by a large lighter, and the top section was bolted on. The East Boston cylinder was left as placed by the lighter until the tunnel heading reached it.

A steel diaphragm and cylindrical air lock were bolted on top of the Chelsea caisson, air pressure was turned on June 26, 1914, and the caisson was sunk without additional weight until the top was at the established grade, about 4.5 ft. above mean high water. The air lock used was 6 ft. in diameter, with a circular trap door in the bottom and a rolling door in the side. Five buckets of ¼ cu.yd. capacity could be accommodated in the lock at one time.

When the cylinder had been sunk to grade, excavation and lining of the shaft were continued below it in successive sections of 5 ft. each. The sections were built by excavating 5 ft. below the preceding section, hanging 12 steel rods with hooked ends to corresponding rods bricked into the preceding section, and bricking upward from the bottom of the excavation to the next section of brickwork above. These hanging-rods, the first set of which was bolted to the bottom of the steel cylinder, were designed not so much to support the brickwork as to anchor the steel cylinder and prevent it from being forced upward by the air pressure on the diaphragm as the depth of excavation increased.

A fresh-water spring encountered in the shaft, under a higher pressure than the tidewater, made it necessary to raise the air pressure above that normally required for the depth, and the steel cylinder had to be loaded to prevent its rising.

When the bottom of the shaft was reached, the tunnel heading was turned and carried in for 45 ft. An air lock was then installed in the tunnel about 15 ft. from the shaft. Two steel diaphragms and doors were set in brick bulkheads 12 ft. apart, bonded into the tunnel walls.

These lock heads had been hung in the shaft previous to the placing of the shaft locks. They could thus be installed and the necessary piping placed through them without removing air pressure from the shaft.

Difficulty was found in making the shaft water-tight when the air pressure was removed from it, due to the straining caused by the excess pressure in handling the spring water, and before proceeding further with the tunnel excavation the shaft was lined with a single thickness of brick laid 1 in. from the wall of the shaft, the space between being filled with rich grout. This made a dry shaft and no further trouble was experienced. Air pressure was then removed from the shaft, work being carried on through the open shaft and tunnel lock.

Tunneling was done by the roof-plate method, as commonly used in small-bore tunnels. By this method, excavation was carried forward without the use of a shield, protection being obtained by supporting the roof and upper portion of the heading with a continuous lining built up of fabricated flanged steel plates (Fig. 7) bolted together to form a partly cylindrical shell with a radius slightly larger than the outside of the completed brick lining. This steel shell was left in place, the brick lining being built inside of it.

The plates used were of ⅛-in. steel, 3 ft. long and 1 ft. wide, curved on a radius of 4.5 ft., with flanges of 1¾x 1¾x¼-in. angles on all four edges. The plates were joined by bolting the flanges together with ⅝-in. bolts, plates in alternate rings being set staggered.

The heading was advanced by excavating around the upper portion of the circumference to a distance of 1 ft. ahead of the steel-plate lining already in place, or just enough to bolt on an additional ring of plates. The breast or face of the heading was then cut down as far as the forward edge of the new ring and the process repeated. At every third or fourth ring, jacks were set up vertically on both sides of the heading to support the roof plates and the ground above them (Fig. 8).

The portion of the circumference of the heading protected by the steel-plate lining depended on the nature of the ground. In hardpan, only 6 ft. of the upper circumference was lined, two plates, or one plate and two half-

sized plates, being used alternately in each ring. In soft ground or gravel more plates were used in each ring, the lining sometimes being carried down on the sides below the axis of the tunnel. In porous soil it was necessary to plaster the ground back of each plate with clay before setting it, and also to keep the joints between the plates well plastered after they were bolted together. At these times the breast was also kept plastered and protected with poling boards in the interval between placing each successive ring of plates.

In general, when the heading had advanced 14 ft. beyond the completed brickwork the heading was trimmed out on the sides and bottom to the proper size, a 4-ft. bench being left in the breast. When ready for brick lining a semicircular profile was set against the bench to line and grade and the invert laid to the springing line. Steel-arch ribs and wooden lagging were then placed, and the arch turned, the brickwork being built out solid against the plates.

The average speed of excavation and lining was 48 ft. per week, with a maximum of 54 ft. in hard ground and

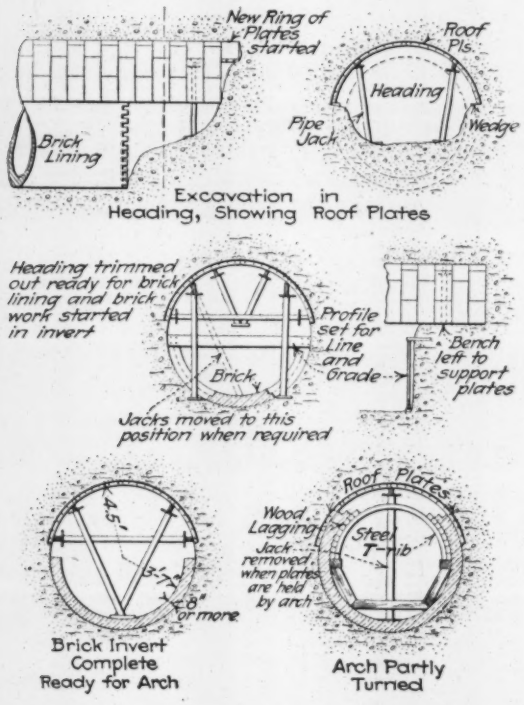


FIG. 8. TUNNEL CONSTRUCTION METHODS; METROPOLITAN WATER-WORKS, BOSTON, MASS.

an average of 27 ft. in gravel. The average force was 16 men per shift, including plant engineers. Three shifts were employed, the work under compressed air being continuous from start to finish.

The brick lining was pointed and plastered with 1:1 mortar as soon as the arch ribs were removed, and washed with neat cement grout. Grout was pumped by hand at frequent intervals to fill the voids above the plates.

Before the heading reached the East Boston shaft two 2½-in. pipes were driven from the East Boston working platform, on the center-line, to tunnel grade. When found in the heading they were bricked into the arch and cut off flush with the inside of the brickwork. One was used to convey air pressure from the tunnel for the sinking of the East Boston shaft, and wires were strung in the other for lighting purposes.

The tunnel was carried to within a foot or two of the shaft before the sinking of the shaft was begun. The tunnel heading was bulkheaded with a light brick bulkhead and the shaft sunk. While work was being done on the shaft the tunnel was stripped of rails and ties, thoroughly cleaned, the invert plastered, and the rails relaid for use in pipe laying.

The only blowout occurred in the East Boston shaft. The first section of brickwork below the steel cylinder was partly blown out, due to lack of bearing power in the soft silty soil surrounding it, the brickwork not having sufficient tensile strength to resist internal air pressure. The entire section was damaged, and it was necessary to reinforce it with an interior band of steel plates, backed with grout for a distance of 6 ft. below the steel cylinder.

The shaft and tunnel were connected and air pressure was lowered to about 10 lb. to discover leaks, which were marked, and calked with lead wool. Pressure was entirely removed on Nov. 18, 1914, and pipe laying commenced.

Pipe Laying.—Pipe laying in the East Boston shaft was done by lighter and completed before concrete was placed. The remainder of the pipe laying was done from the Chelsea shaft, concrete being placed after each pipe was laid. A stiff-leg derrick handled the pipes at the Chelsea shaft, lowering them on to a truck at the bottom of the shaft. The pipes weighed about 5 tons to the length, but were easily rolled to place in the tunnel by man power, the track being laid carefully to line and grade.

Arriving at their destination, the sections of pipes were jacked into place and blocked temporarily at the bell end. The outside lead joints were poured and calked in the usual manner, lead being melted in a gasoline lead furnace. Calking was done both by hand and by air hammer, as convenient, compressed air being obtained from an electrically driven compressor at the top of the shaft.

Concrete was hand-mixed at the top of the shaft, lowered in small cars and turned over on a mixing board in the tunnel before being placed. Sand-bag bulkheads were placed back of the temporary blocking at the bell end of the pipe, and the concrete was shoveled and rammed around the pipe and packed solid in the roof. The bulkheads and blocking were removed from each section when the next section was ready to be filled, the concrete having sufficient set to hold the pipe firmly.

Pipe laying and concreting progressed at an average of 16.5 ft. per day, three shifts of about 12 men being employed.

Inside calking was kept about 10 days behind pipe laying to allow the pipes to assume an even temperature. Tight joints were obtained by this method of inside calking. Manhole branches at the tops of the shafts allow the tunnel to be pumped out at any time and joints recalked from the inside if necessary.

Pipe Connections with Tunnel.—Connections to the tunnel were made by cutting holes in the steel cylinder near the top by the oxyacetylene flame process. An interesting feature in regard to this cutting was the short time required, a hole 4 ft. in diameter in the ½-in. steel plate being cut in 40 min. As these openings were below high-tide level, it was necessary to bulkhead the completed pipe at the top of the shafts until pipe connections were made, to prevent filling the tunnel with salt water.

Water was turned through the completed tunnel on Jan. 19, 1915.

REMOVAL OF OLD PIPE LINES—The abandoned submerged pipe lines, one of which was kept in service until the tunnel was in operation, were removed from the creek by lighter. A diver excavated around the pipe with a water jet and suction hose and attached a sling. From one to seven pipes were removed at each lift. The lighter pulled until a joint parted, the freed section was lifted on deck and the process repeated.

Some trouble was experienced in finding the broken end of the pipe line after each lift, the pipe being buried from 3 to 8 ft. in the silt. This trouble was partly remedied on the second line of pipe removed by threading a light line through the pipe from end to end, a distance of 550 ft., and drawing through a heavy cable. The line was threaded by means of a rod built up of light wooden strips. The cable was used to locate the broken end of the pipe and to help in lifting. This method was not entirely successful, as the cable was cut by the end of the pipe.

PERSONNEL—The work of building the tunnel was done under contract by Coleman Brothers, of Boston. O. S. Heyer was Superintendent for the contractors during practically the entire time the work was in progress.

The completed tunnel forms an important link in the distribution system of the Metropolitan Water-Works, the design, construction and operation of which are under the direction of the Metropolitan Water and Sewerage Board, of which Dexter Brackett is Chief Engineer. Clifford Foss, Division Engineer, was in charge of construction work under the contract, and the writer was Resident Engineer.

Failure of Small Earth Dam

BY GEORGE H. RUHLING*

A small earth dam on the grounds of the Mohawk Fishing Club, near Tiffin, Ohio, which had been repaired after being seriously damaged in the flood of March, 1913, failed again on Feb. 1, 1915. The dam was about 400 ft. long and 18 ft. high at the deepest section, which was where failure occurred. Originally it had a wooden spillway. In the 1913 flood this proved too small and the water broke over the dam, washing out a large section about midway between banks.

Nothing was done with the dam until the spring of 1914, when the club decided to refill the washed-out section with earth, slope both faces of the dam, and give these faces and the top a 4-in. coat of concrete reinforced with woven-wire fencing. This was considered sufficient to make the whole dam a spillway for all flood waters. The ordinary flow of water was taken care of through a few small drain tile which emptied into an old race along the north side of the dam.

The earth fill was made by teams and scrapers, no attempt being made to compact the earth other than by driving over it. The earth used for filling was principally loam, with a small amount of gravel and sand. Directly after the fill was made and the banks sloped the concrete facing was put on. A cutoff wall 3 to 4 ft. deep was poured along the lower edge of the downstream facing.

MOHAWK DAM, TIFFIN, OHIO, AFTER FAILURE

Late in the summer of 1914 the part of the facing over the fresh fill showed signs of settlement. After this had settled several inches another layer of concrete was added to the top, bringing the crest level again. However, settlement continued, and by winter horizontal cracks began to appear in the concrete near the top. By January, 1915, vertical cracks appeared and the dam began to leak, the water coming out below the cutoff wall. This action soon eroded the newly made fill, which in turn caused the cracks to widen. About this time several days of zero weather set in, followed on Jan. 31 by a warm rain. On Feb. 1 the facing completely ruptured and the water broke through in a large mass, tearing out the large gap shown in the accompanying view.

This disaster so weakened the faith of the club members in dams that nothing further has been done to repair the place.

*Deputy County Engineer, Seneca County, Tiffin, Ohio.

Farm Tractors operated by gasoline or oil engines, which have been extensively used in the Middle West during the past five years, have been an economic failure in a large percentage of cases, according to a bulletin of the Department of Agriculture prepared by Arnold T. Yerkes and H. H. Mowry. The tractors used have cost new from $2000 to $3000 or more, have been available for use in only a limited portion of farming operations, so that they have been in actual use only a small part of the time, have required a large expenditure for repairs, and have generally lasted only four or five years before being put out of service. The sale of this class of tractors has fallen off very largely, but a large number of smaller and cheaper tractors, costing from $300 to $700, are being marketed.

Reinforced-Concrete Floating Caissons for the Welland Ship Canal

The Lake Ontario entrance to the new Welland Ship Canal is to be made through an entirely new cut about three miles east of Port Dalhousie. At this location, known as Port Weller (in honor of J. L. Weller, the engineer so long connected with the Canadian canal service and now engineer-in-charge of the new Welland Ship Canal), a harbor is to be made as an entrance to the canal by throwing up two large embankments extending out into the lake. At the shore and lake end of these embankments the channel is to be narrowed to approximately canal width and lined with reinforced-concrete walls which will form a retaining wall for the earth and at the same time a landing place for ships. These walls are to be constructed from reinforced-concrete boxes built as floating caissons at Port Dalhousie, and towed down Lake Ontario the three miles to the harbor entrance, there to be sunk in their proper location on a prepared bed and filled with earth and rock to form the permanent retaining wall and guide for the harbor entrance.

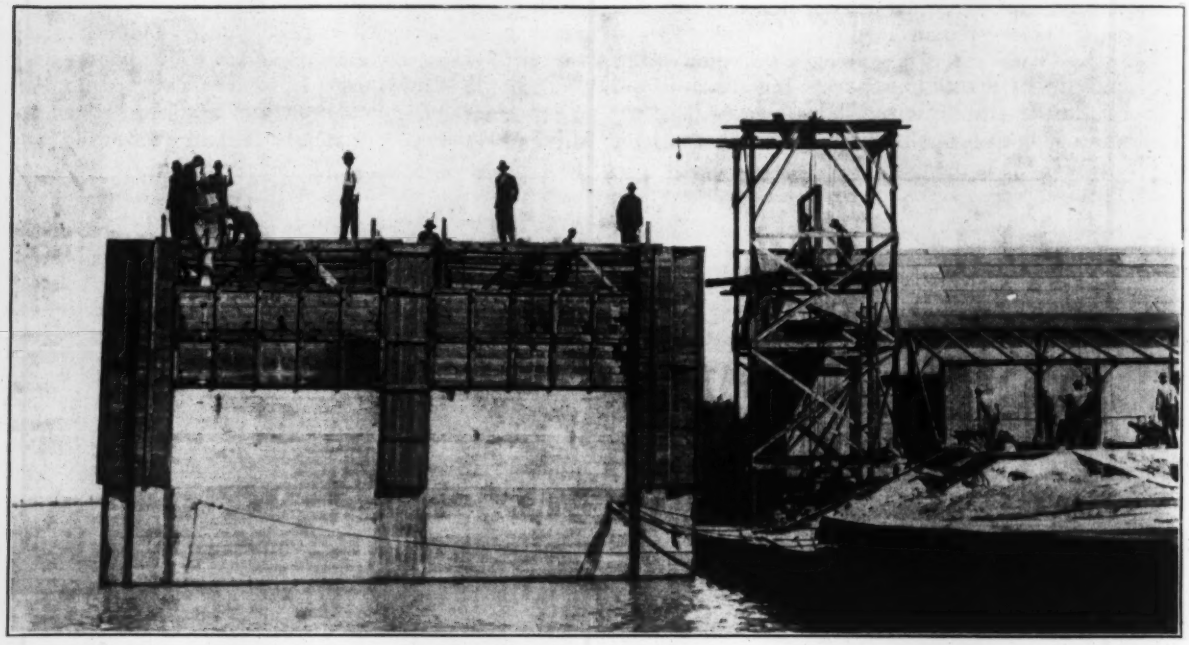


FIG. 1. FLOATING CAISSON DURING MANUFACTURE

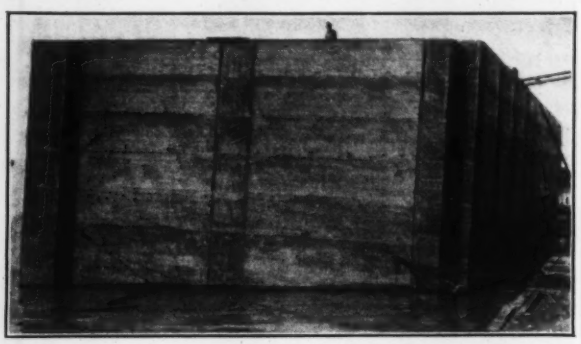


FIG. 2. CAISSON WITH PONTOON SUBMERGED AND FORMS REMOVED

There will be 53 such caissons built. The general dimensions and design are shown in Fig. 3. The total length of each caisson is 110 ft. 10 in., width 38 ft., and depth 34 ft. It is divided into 18 compartments by means of one longitudinal center wall and eight cross-walls. The interior walls making the various cells are provided with rectangular openings 8x14 ft., the bottom of each opening being 22 ft. above the bottom of the caisson. The purpose of these openings is to reduce the weight of each caisson and to bring the center of gravity lower down. They are placed high on each partition, so that a leak into one cell will not necessarily allow the water to flow into the next, thereby confining the effect of any leakage and making the caisson more secure against sinking.

Each pocket has a temporary timber floor, or bottom, which is wedged in place in such a way that after the caisson is sunk the wedges are pulled out by chains extending to the top of the structure (Fig. 4). The patents for these bottoms are held by J. L. Weller and F. E. Stearns, the Designing Engineer of the canal. Sinking of the caissons will be accomplished by letting water into the pockets through seacocks in the outer wall. By admitting the water carefully, the caisson can be sunk to within a few inches of the bottom; when brought into exact position and line a little more water will bring it to rest. As will be noticed in Fig. 2, each caisson has vertical projecting ribs at opposite ends, so arranged that the adjacent caissons can be keyed.

It is the intention in setting the caissons in place to proceed as follows: The seat for each is to be dredged to a little below the required grade, and then three windrows of broken stone are to be placed by means of spouts and leveled off in such manner that one windrow comes directly under each of the longitudinal walls. When the caisson has been satisfactorily sunk to its final position and entirely filled with water the wedges will be pulled and the temporary wooden bottoms will float to the surface and be removed. The pockets are then to be filled by

dredges with selected excavation from the harbor, not necessarily rock, as that will probably not be available. By the use of the removable wooden bottoms, the caissons can be brought to a firm bearing on the harbor bottom, and will not be subjected to the stresses which would be in-

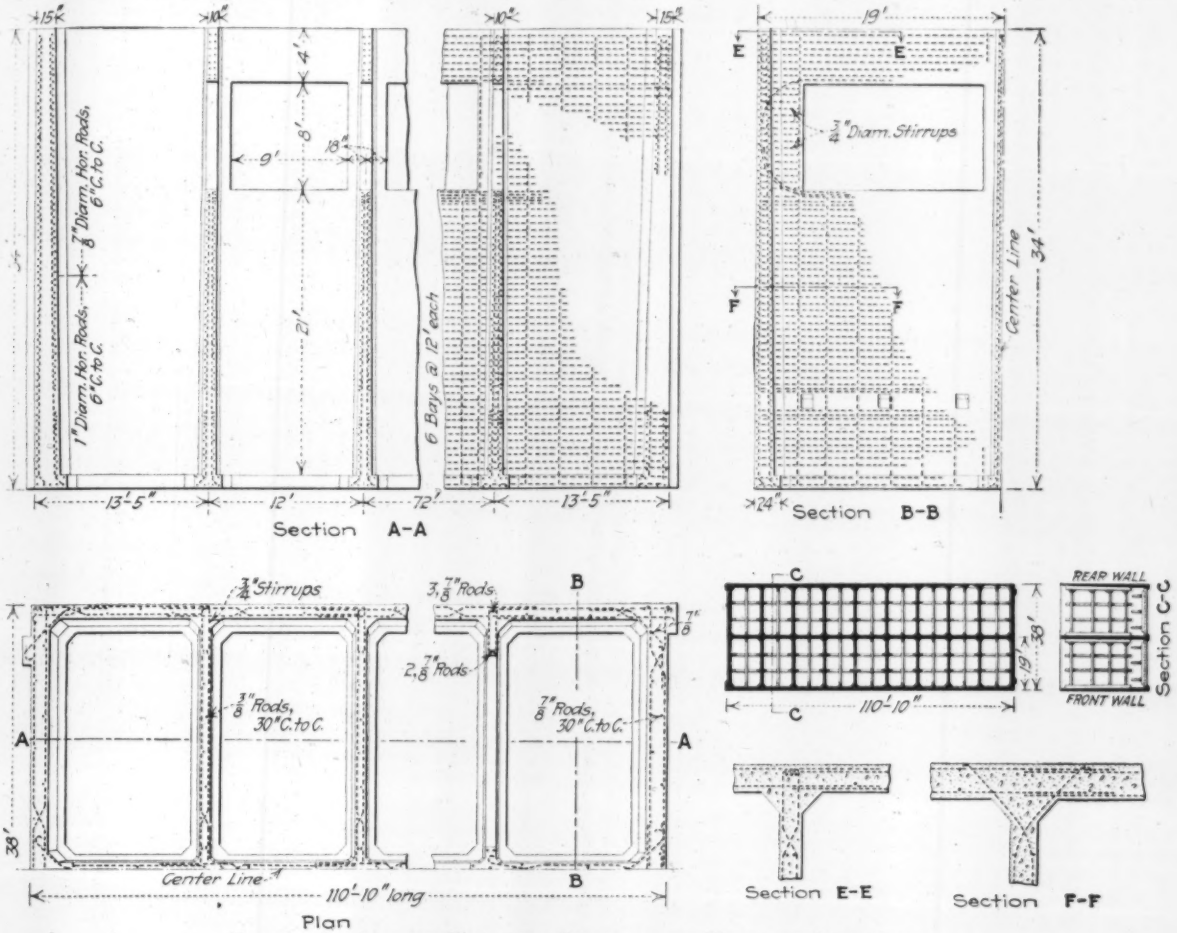


FIG. 3. DETAILS OF FLOATING CAISSONS FOR WELLAND SHIP CANAL

duced by a solid bottom resting on an uneven foundation, at the same time supporting the fill inside the cells.

In building the caissons a pontoon is used consisting of a rectangular open-top box with inside dimensions the same as the outside of the caisson. It is about 9 ft. deep and is built in sections consisting of bottom and four

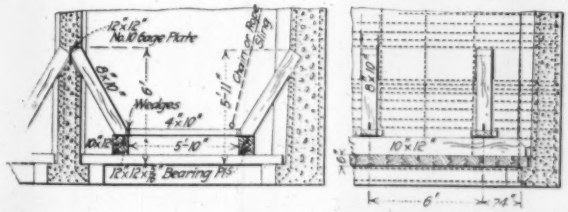


FIG. 4. DETAILS OF WOODEN REMOVABLE BOTTOMS TO CAISSONS

side pieces. The latter are connected together at the corners and to the bottom by means of bolts which can readily be removed by a diver, so that when a caisson is completed and the temporary bottoms placed, the sides and ends of the pontoon are released and float to the surface. The bottom is then pulled out from beneath the caisson, so that its upper part can be taken off as the caisson with its pontoon sinks under the growing weight of the construction (Fig. 1). The temporary bottoms are placed after the formwork in the pocket has been removed. A water-tight joint is made between the bottom and the concrete ledge upon which it rests by placing between them a rope of jute yarn covered with canvas, which is tightly squeezed down by the wedges that hold the bottom in place.

On the one caisson which has been built so far, the contractor poured the concrete in lifts of 3 ft., placing the horizontal reinforcing steel in position for each lift and pouring concrete alternately. The vertical steel, extending from top to bottom without break, is placed before any concrete is poured.

The design of the caissons was somewhat complicated by the varying stresses to which they would be subjected during the floating and sinking process and also on account of the possibility of any one of the pockets becoming filled with water through an accident or leak in one of the temporary bottoms. The loads to which each caisson would be subjected are, successively, the exterior water loads on the floating caisson, the exterior and interior water loads as it sinks, and the interior fill loads on the submerged caisson when in position and during filling. It was found that to withstand these stresses, and the possibility of one of the pockets becoming accidentally filled with water, would require an amount of

steel considerably greater than was desirable from the point of economy. Particularly during the sinking and before the cells are filled with earth there is for a comparatively short time a very heavy exterior pressure. To meet this without unnecessarily strengthening the walls themselves in the caissons to be built this season a wooden bracing, as shown in the small-scale drawings in Fig. 3, wedged in the pockets has now been adopted. This will be placed before admitting the water and removed before the pockets are filled with earth. It is to be so arranged that the spans over which the water loads act will be reduced to 6 ft. with a consequent reduction in the bending moment.

The walls are designed as slabs, using the standards recommended by the Joint Committee for the permanent loads, but for temporary loads during the sinking operation the stress of the steel is run up as high as 25,000 lb. per sq.in. Each caisson requires 934 cu.yd. of concrete and 112,000 lb. of steel.

Power Development at the Austin Dam

By Frank S. Taylor*

The reconstruction of the Austin, Tex., dam, described in detail by the writer in Engineering News, June 3, 1915, involved building new works for the development of electric power, although most of those parts of the power plant which had been left standing were used, including the headgates. The new plant, as shown by Fig. 2 in the previous article, is on the east bank just below the 61-ft. section of old dam utilized in the reconstruction.

*Austin, Tex.

Head Works

The intake is in the old masonry bulkhead on the east side of the river and has three 9-ft. openings for the penstocks. Each opening is divided by a vertical H-column across the face of the flange at the end of the penstock. There is a headgate, 5 ft. wide and 10 ft. high, for each of these openings, made of 4-in. creosoted yellow pine, bolted together and braced with angle-irons held to the wood by lag screws. One of each pair of gates has a small filler gate. At minimum low water the gates are submerged 3 ft. Each is worked by a hand-operated worm-gear hoist.

The racks were designed as required by the city officials and are made of ¼-in. steel bars, 2 in. wide and 1 ft. long, spaced ⅞ in. c. to c. The total length of rack is 36 ft., and the slope is 15 deg.

The three penstocks are 9 ft. in diameter inside and are made of ¼-in. steel plate covered with concrete (reinforced with steel wire mesh) to give a hexagonal casing of 8 in. minimum thickness.

A 3-ft. surge pipe leaves each penstock as close as practical to the turbine casings; these run out horizontally through the wall of the power house and then turn vertically upward, being anchored to the building.

Just outside the power-house wall a vertical vent pipe rises from each penstock. Two of these are 66 in. in diameter and one is 48 in. The water normally stands in

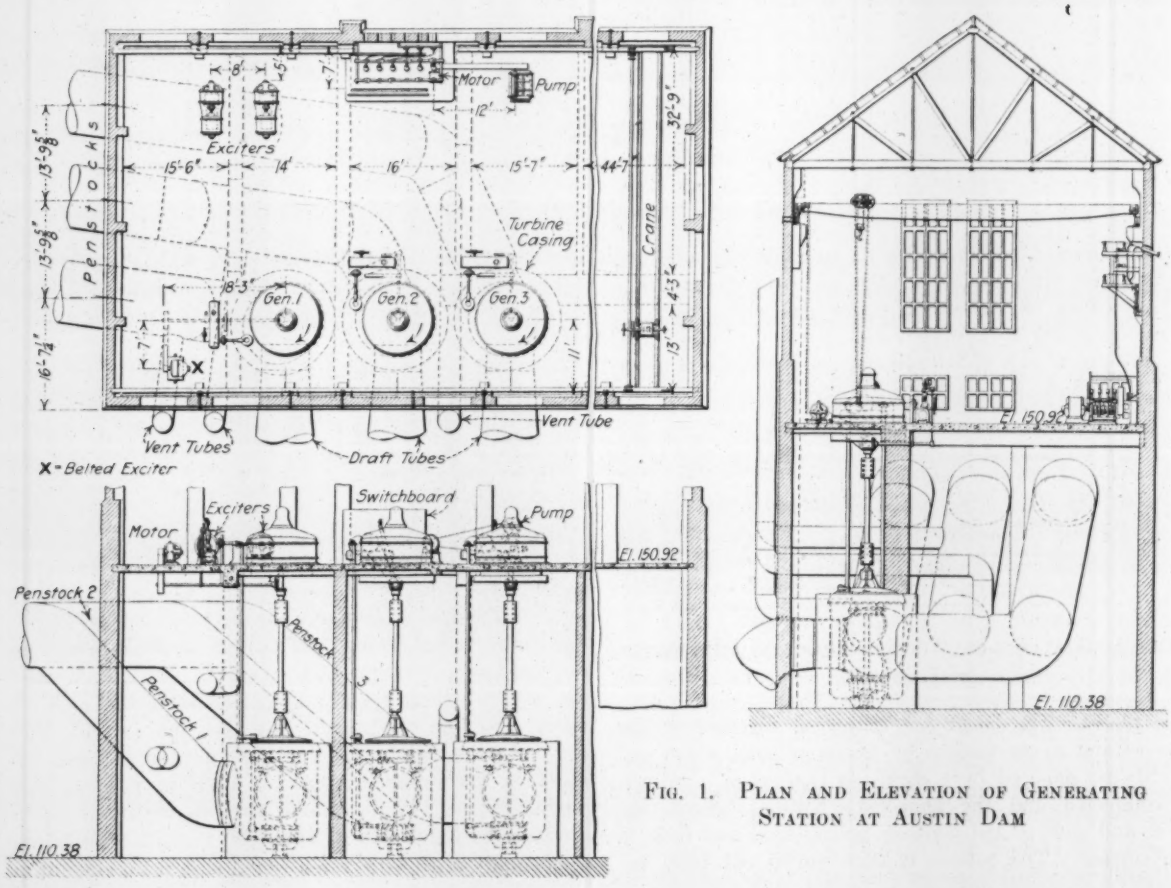


Fig. 1. Plan and Elevation of Generating Station at Austin Dam

them about 4 ft. from the top. When the turbine gates are closed rapidly water is ejected from both surge and vent pipes.

Power House

The generating station measures 118 ft. long by 50 ft. wide inside, and has a clear height of 28 ft. above the generator floor. From the generator floor down to the bottom of the turbine room is 40 ft. The foundations are concrete on rock; ashlar masonry is laid up to the generator-room floor, which is supported by reinforced-concrete beams and columns. Above this level the walls of the station are of yellow pressed brick. A timber and iron roof truss is used with slate covering.

The walls vary from 2 to 3 ft. in thickness. Internal pilasters on both longitudinal walls support a crane runway. On the longitudinal wall away from the stream are three heavy external buttresses running up the entire height. A gallery, 6 ft. wide and 9 ft. above the operating floor, runs around three sides.

Where each generator was to sit, 9-ft. holes were left in the generator floors. This diameter is 1 ft. less than the width of the generator frame, and all parts of the turbine may be raised through these openings when desired.

Reinforced-Concrete Turbine Casing

The designers of this station believe that their use of a cylindrical reinforced-concrete casing, separate from the foundation, is unique. This particular design (shown in Fig. 2) was used because of the larger cost of a spiral-shaped casing, which is not warranted by any slight gain in efficiency with these small units. Concrete was used instead of steel in order to suppress vibration with the height of casing necessary.

The amount of steel reinforcement used is large on account of the possibility of cracking, and the stresses in it are limited to 10,000 lb. per sq.in. Where the penstocks enter the casing and where the draft tubes pass through, angles are riveted around the outer surface of the pipes to increase the contact with surrounding concrete.

Each turbine chamber is closed by a heavy ribbed cast-iron cover, split and bolted to the Z-ring which projects slightly above the top surface of the concrete. The

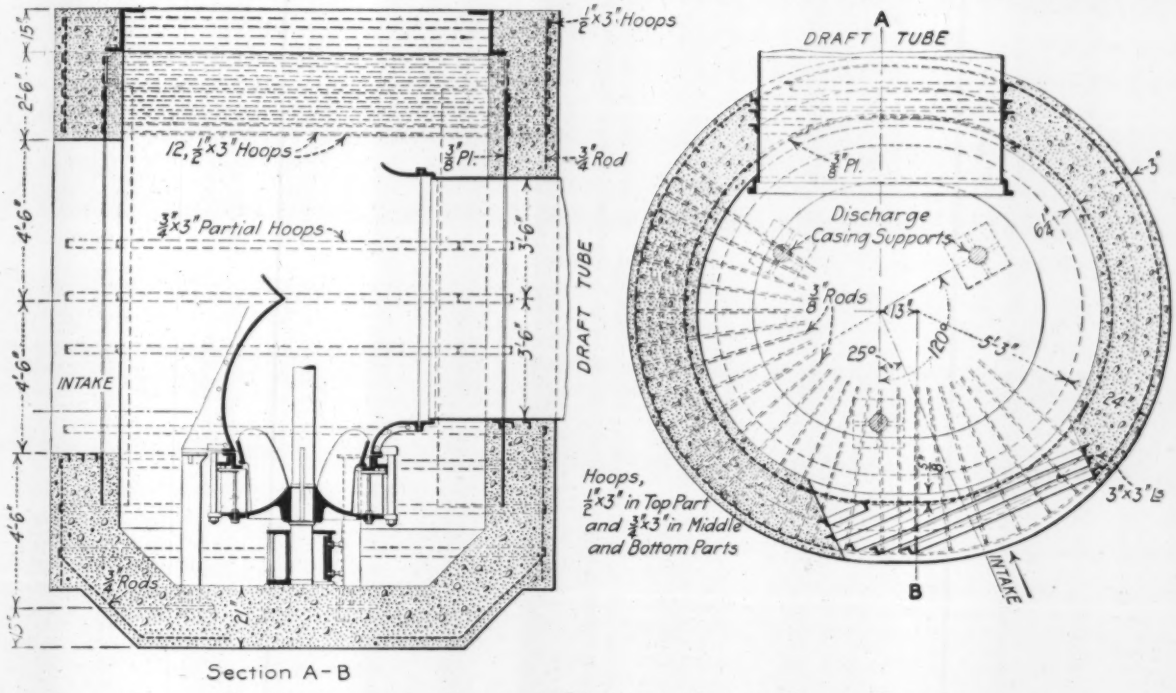


Fig. 2. Reinforced-Concrete Casing for Double-Runner Turbine

cases have now been in service about four months, and have not shown any defects.

Draft Tubes

The draft tubes leave the casing at mid-height. Just outside the casing the diameter changes from 7 to 7½ ft. To this pipe is attached a 65-deg. elbow which flares to 9 ft. in diameter. Finally, there is a straight section of 9 ft. pipe, inclined 25 deg. to the vertical and with its lower end submerged 18 in. at minimum low water. The ends of the draft tubes are supported by a concrete saddle in a pit which guides the water to horizontal flow and reduces the velocity to 3 ft. per sec.

The tailrace is 300 ft. long. It provides a clear waterway of 200 sq.ft. section below low-water elevation and runs from the draft-tube pit out into the main channel of the river. The maximum velocity here is about 4 ft. per sec.

Generating Units

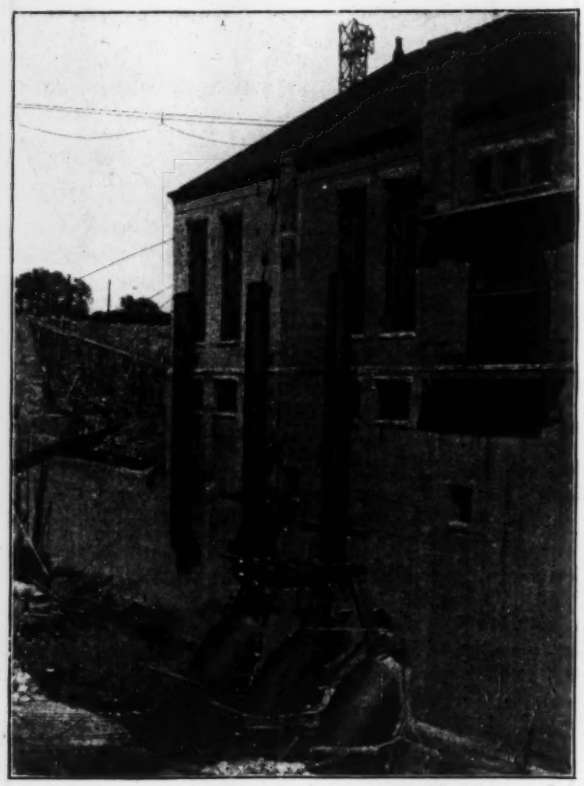
There are three 1800-kw. 300-r.p.m. vertical-shaft generating units, comprising a three-phase 6600-volt revolving-field generator and a pair of 36-in. runners discharging into a common, horizontal draft tube. The runners are set in the reinforced-concrete chamber already described, out of which the draft tubes pass as shown in Fig. 2.

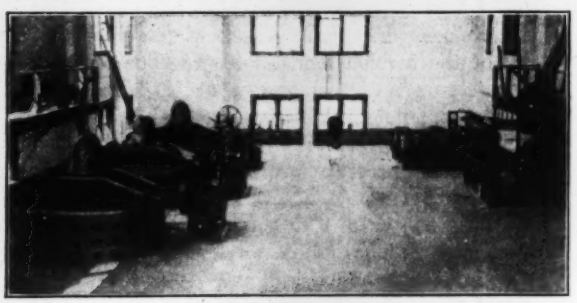
The weight of the rotating parts for each unit, 44,000 lb., is supported by a single top thrust bearing, which was made in Sweden. The runners develop an upward

thrust in operation, reducing the load on the bearings to about 20,000 lb. Each bearing comprises two concentric tool-steel races, one carrying 19 and the other 15 2-in. steel balls. There are additional (guide) journals at the top and bottom of the generator frames and at the top and bottom of the turbine cases. The last bearing is submerged, and is therefore an iron frame with adjustable lignum-vitæ blocks.

Auxiliary Apparatus

There are two 75-kw. 125-volt exciters, each driven by a 440-volt induction motor. One unit is a reserve. There is in addition a 15-kw. exciter, belted to a geared shaft, and used in starting the plant after a shutdown and until the motor-driven exciters are in regular operation. Oil pressure is used to operate the sluice gates of the dam. The oil pump (motor-driven) is in the power station.





Figs. 3 and 4. Exterior and Interior of the Austin Power Station

There are three small station transformers supplying the 440-volt motors. The station is lighted from the exciter busbars, but double-throw switches make it possible to put the lighting on to 125-volt taps from three small station transformers.

Switchboard

The switchboard has seven panels, two for the exciters, three for the generators, one for the outgoing feeders and one blank. The generators supply current directly at transmission potential, 6600 volts. The various oil switches are mounted on the building wall directly in the rear of the switchboard. The generator switches are non-automatic and are manually operated from handles on the board. The main switch may be manually operated, but it has also a trip-coil overload release and relay control.

Transmission Line

A three-mile single-circuit transmission line was one of the first pieces of construction on this project, since power for construction was supplied from the City of Austin over it. There are six No. 0000 aluminum-cable conductors connected in parallel pairs to give a single three-phase circuit. The conductors are mounted on standard 6600-volt porcelain pin-type insulators, carried on wooden poles (Michigan cedar) 40 ft. long, 23 in. in circumference at the top and 53 in. at the bottom. Poles are spaced from 180 to 200 ft. There are two cross-arms; the upper one is 3½ ft. long and the lower one 7½ ft. Both are 5x6 in. in cross-section. An overhead ⅜-in. stranded galvanized ground wire is carried on each pole.

In the steam station operated by the City of Austin there are three 1500-kv.-a. transformers, stepping down the received current to 2300 volts, at which potential the steam station operates in parallel as an auxiliary and emergency reserve.

Tests

The efficiencies of the generators, as tested in the manufacturers' shops, ranged from 91.9% at half load to 95.3% at 5/4 load on 80% power factor; for 100% power factor these figures were 93.6 and 96.6% respectively. The machines were tested in a horizontal position and the figures were therefore lower than obtain in place due to the extra bearing friction.

For testing the complete plant a weir was built across the tailrace and provided with a notch 3 ft. deep by 29 ft. long. As a result of a six-hour test on each machine with a non-inductive load (furnished by resistance coils in submerged tanks) the average overall efficiency at full load was 83½%. This shows an average efficiency of 87% for the waterwheels.

Engineers, Etc.

The turbines and gate hoists were made by the Platt Iron Works, the generators, exciters and transformers by the Crocker-Wheeler Co., the thrust bearings by the S. K. F. Co., the turbine governors by the Lombard Governor Co., and the steel plate work by Payne & Joubert, of New Orleans. The contractor for the complete development, including the new dam, was the William P. Carmichael Co., of St. Louis. Lamar Lyndon, of New York, was Consulting Engineer and Frank S. Taylor, of Austin, Tex., Resident Engineer.

New Rating Flume for Current Meters, Bureau of Standards

A 400-ft. trough, or flume, for rating-tests of current meters has been built at the Bureau of Standards, Washington, D. C. It is located on the hillside just south of the Bureau Buildings; the old trough which it replaces was at Chevy Chase Lake, about five miles north.

The Bureau gives the following data on the new flume:

Construction of Trough

The flume is 400 ft. in length, 6 ft. in width, and designed for a working water depth of 6 ft. It is built of concrete, with reinforcement for water pressure and shrinkage.

The structure is continuous throughout its length, without contraction joints. The longitudinal reinforcement to provide against cracking from temperature change consists of 16 1-in. steel rods (old material of this size was on hand, otherwise rods of smaller diameter would have been used). The lateral reinforcing against earth pressure consists of ½-in. rods, continuous down both walls and across the bottom, spaced 6 in.

For watertightness 1 : 2 : 4 concrete was used, the gravel passing a 1½-in. mesh and being retained on a ¼-in. mesh sieve. It was mixed quite wet. When the forms were removed the surface was washed with a pure cement grout applied with a brush. Outside forms were built around the entire structure. The inside forms were built in sections and used repeatedly.

The ground on which the tank is located is sloping. Drainage is provided by 6-in. agricultural drain laid along the entire uphill length of the tank, with five branches carried beneath the tank to low ground.

Bolts were placed in the top of the walls to receive leveling plates for 30-lb. rail to carry the car supporting the current meters under test. The rails were laid and leveled and the concrete then poured to form the coping (shown in the view of the completed tank) and brought up under the rails to a level with the rail base.

Carriage

The rating car is motor-driven, with a Waterbury hydraulic gear for speed control. Observations of time, distance, and revolutions of the meter are made by chronograph.

Tests can be made from a velocity less than 0.1 ft. per sec.—below the point at which ordinary types of current meter begin to record—up to velocities of about 20 ft. per sec. (14 mi. per hr.). The speed change is continuous, and is actuated by a single controller. The motor runs at constant speed, the hydraulic gear giving the speed changes. The recording apparatus, now being constructed in the Bureau shop, will shortly be completed.

Fig. 1. Reinforcement (Inner Form Not Yet Placed)

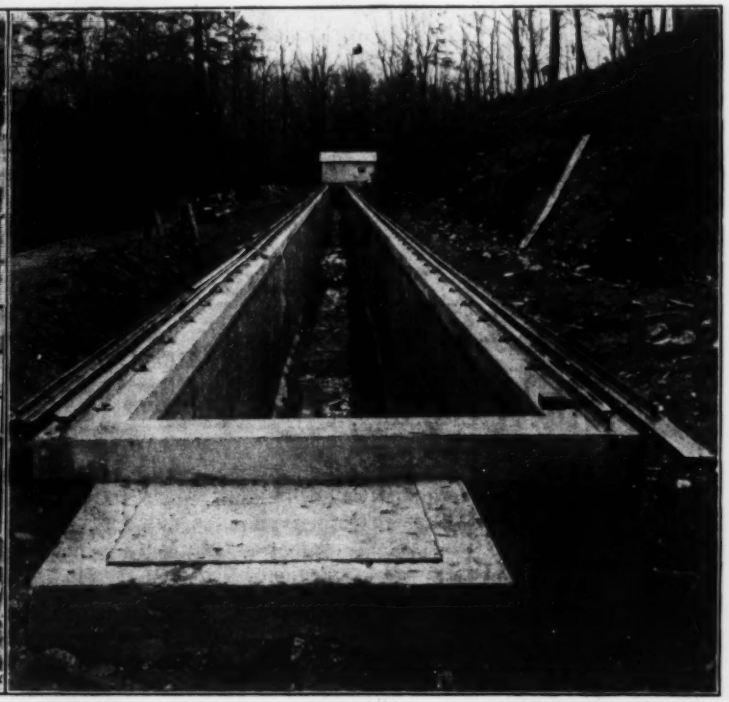


Fig. 2. Completed Trough. (New Testing Trough for Rating Current Meters, Bureau of Standards, Washington, D. C.)

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An Insulating Skin on Aluminum, so thin and flexible as to make small aluminum wire as economical of space in coils as copper, has been developed by C. E. Skinner and L. W. Chubb of the Westinghouse Electric & Manufacturing Co., of Pittsburgh, and was described in a recent paper presented before the American Electrochemical Society. By different processes two types of films are produced. One is smooth and iridescent and the other white and abrasive. The latter is the better, being from 0.0001 to 0.0004 in. thick and standing from 200 to 500 volts. Two wires can be pressed together so as to indent without breaking the film; but if there is relative motion the abrasiveness of the film will expose the metal for a short circuit. The material is fireproof and has mechanical strength to support the wire in small coils above the melting point. The film is made by passing the wire through electrolytic baths (solutions of borax, ammonium borate or sodium silicate), the wire being the anode.

How to Express Seepage Losses from Irrigation Canals*

By Samuel Fortier†

In recent years some writers on this subject have advocated that seepage losses from canals should be expressed in feet-depth over the wetted area in a given time, and they have used the letter c to indicate this unit loss. If the writer is not mistaken, it was R. G. Kennedy, when executive engineer of the Bari Doab Canal in India, who first adopted, in 1882, the letter c to represent the depth of water in feet absorbed in a given time. The purpose of his experiments was to determine the rate of absorption into the soil as well as the evaporation into the air when water was turned into the checks of the cultivators. The value of c was obtained direct by reading a gage placed in each check. This unit for such a purpose is entirely proper and has been repeatedly used by the writer in the same way for a like purpose.

Again, in recent years extensive experiments have been carried on in India to determine the relative efficiency and cost of various kinds of canal linings. These experiments consisted in making a number of short channels side by side within an inclosure, applying different linings, filling each with water and then noting the loss in a given time. This loss, or sinkage as it is called, is also expressed by c. Here again the loss, or sinkage, can be measured direct and no better unit could well be used.

It was likewise Kennedy who extended the use of c to the small watercourses of the Hindoo farmers and from these to the distributaries, branches and main canals.

Notwithstanding the last-named use in India, the writer contends that the unit c should be confined to flooded areas on irrigated fields, reservoirs, checked-up watercourses, and in general to water surfaces where the loss can be measured direct, and not to water in motion, where the losses cannot be measured direct in terms of a unit of this character. In support of this contention, only two sets of conditions need be considered. One of these represents a canal which carries either a full or a partial supply and the other the new or dry canal. In the first case, one determines the loss by measurement in a given section or reach of the canal. The length of the section depends on the discharge and on the degree of accuracy of the water measurement. In a furrow it is possible to determine the loss in 100-ft. lengths, whereas in the average-sized canal the section may be several miles in length. Now when the superintendent has ascertained the loss by current-meter measurement or otherwise in any given section, or between any two adjacent lateral gates of the canal under his charge, he can then apportion the net flow equitably among the users. To oblige him to determine, after he knows what the seepage loss is, the number of square feet in the wetted surface and apportion the total loss as previously found evenly over this area would be, in the opinion of the writer, a useless waste of time and energy. Such a procedure would be on a par with that of the trial of Bill Noaks by Captain Blakely as described by Mark Twain in "Roughing It." The captain wished to hang the accused first and try him afterward.

Again, there can be no doubt of the fact that the old adage, "Incessant change is the law of nature," applies with striking force to the irrigation canal. The discharge today may be quite different from what it was yesterday or will be tomorrow. Each of these changes would call for a new survey or estimate of the wetted area and a new numeral to represent the value of c.

Similar difficulties, not to mention incongruities, are encountered in a consideration of the second case, that of the new or dry canal. In this case, however, the bed of the canal is not hidden. One can, if he is so disposed and has the time, examine each unit of canal bed and assign to each its particular value of c. Since water is not likely to be absorbed by any two superficial units at exactly the same rate, the number of values assigned to c is likely to be large. If one is good at guessing he may examine larger areas as units and assign a value to each. Even under this more practical method he has no assurance that the conditions as found in the dry or newly constructed canal will remain the same for even one season after water is turned in. As has been shown, seepage from such channels depends on so many and varying factors that it is well-nigh impossible to estimate beforehand what the rate of absorption will be.

The engineer who is called on to make an estimate of this kind on a new canal may follow one of two courses. In the first of these, he may determine the extent of the wetted area, estimate the value of c for each part of the perimeter and for each kind of material and with the aid of other assumed or known hydraulic elements compute the estimated seepage loss.

In pursuing the second course, the engineer makes a careful study of all the conditions which are likely to affect the escape of water from the canal. These should include the amount of sedimentation per season and its effect on the character of the material, the tendency to scour under high velocities, fluctuations in depth, velocity and extent of wetted surface, inflow of seepage water from higher irrigated lands, evaporation from wet banks and water surfaces, transpiration from tree growths, leaks from structures, aquatic vegetation, the temperature of the water carried as well as that of the soil, and the location of the water table either beneath or adjacent to the canal. After a comprehensive study of existing and possible future conditions, together with all of the available data pertaining to the seepage losses from canals of like capacity traversing materials of like character as regards porosity, he will be in a position to estimate with reasonable accuracy the percentage of loss due to seepage, which may be expressed either in second-feet per mile or in percentage of the flow per mile.

The chief arguments advanced in favor of what we may call Kennedy's unit c may be reduced to two. Some hold that the loss varies chiefly with the depth of water in the canal and that a unit like c should be adopted in order to eliminate this main factor in seepage losses. Others seem to minimize the effect of depth of water by asserting that the wetted perimeter is the one important factor and that the loss should be expressed in terms of a unit of this surface. In regard to the first, the writer showed in Engineering News of June 3, 1915, that depth of water is not the main factor, but is merely one of a dozen or more factors which influence seepage. In support of the second argument I quote the following from a recent writer: "The [seepage] loss is unquestionably

*This article, although complete in itself, is a continuation of one on "Transmission Losses in Unlined Irrigation Channels," by the same author, published in "Engineering News" of June 3, 1915.

†Chief of Irrigation Investigations, Office of Experiment Stations, U. S. Department of Agriculture, Washington, D. C.

a function of the wetted perimeter and must be expressed in terms of quantity lost per unit of wetted area, if comparable results are to be obtained." This writer overlooks the fact that the perimeter is only one of several hydraulic elements pertaining to a canal and that its relation to the loss does not differ from that of a number of other elements. This fact is brought out in the accompanying table, in which the figures are given for the most part in round numbers and in consequence are only a close approximation.

VARIATION OF HYDRAULIC ELEMENTS IN STANDARD CANAL SECTIONS

(Where V = 2.5; upper slope, 1½ to 1, and lower slope, 2 to 1)

Capacity, sec.-ft.	Bed Width, ft.	Depth of Water, ft.	Width of Water Surface, ft.	Area of Water Section, sq.ft.	Perimeter, ft.	Hydraulic Radius
1	1.0	0.3	1.6	0.4	2.21	0.18
3	1.5	0.5	3.25	1.2	3.52	0.34
5	2.5	0.6	4.6	2.0	4.92	0.41
10	3.0	0.9	6.15	4.0	6.64	0.62
25	4.0	1.5	9.25	10.0	10.07	0.99
50	5.0	2.25	12.88	20.0	14.09	1.43
100	10.0	2.7	19.45	40.0	20.87	1.90
200	18.0	3.35	29.72	80.0	31.53	2.54
500	30.0	5.51	48.02	200.0	50.79	3.94
1000	50.0	6.50	72.75	400.0	76.25	5.24
2000	90.0	7.75	117.13	800.0	121.36	6.61
3000	120.0	8.85	150.98	1200.0	155.72	7.70

It will be noted that all of the elements vary in the same direction, and the loss which increases as the discharge increases might be computed as some function of any one of these elements.

Lastly, if it be irrational, as someone has recently said, to compute and express seepage losses on comparatively short lengths of canals on a percentage basis, is it not equally irrational to classify earth, loose rock or solid rock removed from a railroad cut or canal on a percentage basis? Why not insist that the construction engineer measure the volume of each kind of material taken out? This task would not prove more impracticable than that of assigning to c correct values for each unit of the wetted area of a canal. In like manner one may question the practice of the electrical engineer. In transmitting electric current through a wire there is also loss, but from other causes. The causes of these losses are not so complicated as those of seepage from canals, yet he usually expresses them on a percentage basis.

Meeting Water-Supply Shortage at Henrietta, Tex.

By Thos. L. Fountain*

Henrietta, Tex., has recently supplemented an inadequate underground water-supply by water pumped from a stream at muddy high-water stages, stored and settled, and then repumped to a standpipe.

The city has an estimated population of 2500. A supply from wells 16 ft. in diameter and 30 ft. deep having proved inadequate, a local investigation showed the only feasible source of additional supply to be the Little Wichita River, a stream with a sparsely populated drainage area of a thousand square miles above Henrietta. Although the annual rainfall at Henrietta is about 27 in., the river bed is dry the larger part of the year. During the winter more or less frequent rains maintain a flow which changes quickly from a few to several thousand second-feet.

In the summer and fall, as a rule, there are sharp rises in the river once in six weeks, with a decline to zero in about two weeks. An impounding reservoir was wholly impracticable on account of the flatness of the valley and the volume of silt carried by the river. At times of greatest turbidity the stream carries 0.5% of sediment.

The problem was solved by installing at the river a pumping plant of large capacity, as related to the daily water consumption; pumping river water, when it can be had, to a storage and settling reservoir; and repumping this water to an existing standpipe. Only $20,000 was available for construction, right-of-way for two stretches of force main and for a reservoir site.

The river-pumping station consists of a 150-hp. boiler and a 3,000,000-gal. single-stage steam-turbine-driven centrifugal pump. The suction lift is 18 ft., and the total lift, including friction, is 95 ft. Until funds are available for extending the natural-gas service to the river coal has to be carted from the city. Water for steam purposes is run back from the settling reservoir when the river pump is not being operated and is stored in a small earth reservoir having a boiler-feed capacity sufficient for 15 days.

The force main from the river pump to the storage reservoir is of 12-in. wood pipe, 1600 ft. in length.

The storage reservoir has a high-water area of 7 acres, a maximum depth of 17 ft. and a capacity of 32,000,000 gal. It was formed by building two earth dams having a volume of 23,000 cu.yd. Practically all soil had been removed from the site by erosion. By building a third dam, 34,000,000 gal. additional storage could be obtained at a cost of $5000. The city bought 39 acres of land for the present and prospective reservoirs and to control a small drainage area tributary to the reservoir.

Most of the suspended matter is removed in the settling reservoir, leaving the water with a bluish tinge. Plans were made for a coagulation basin to treat the settled water on its way to the second pump, but lack of funds prevented their execution.

The 8-in. steel outlet pipe from the storage reservoir is laid in concrete in a trench beneath the lowest part of the dam. On the water side this pipe terminates in a 90-deg. elbow. A 20-ft. length of 8-in. steel pipe, connected with this elbow by means of an elbow and nipple, forming a swinging joint, has a ⅝-in. wire cable attached to its free end. This cable, in turn, is attached to the drum of a winch set on top of the dam and is used to raise or lower the outer end of the pipe as the water level in the reservoir varies. To prevent the entrance of leaves, sticks or large objects, the outer end of the pipe is capped, the cap and 2 ft. of pipe being perforated with ¾-in. holes.

The reservoir outlet pipe extends a short distance to a double-acting triplex pump with a capacity of 500 gal. per min. The pump is operated by a 50-hp. gas engine, supplied with natural gas. A 6-in. steel force main 5300 ft. long leads to the standpipe, which is still supplied with well water when available. This pumping equipment and force main were bought second hand.

*College Station, Tex.

A Standard for Car Seating Width was adopted by the Public Service Commission of New York City on May 28. The standard adopted is 17.78 in. for each passenger. This is the average seat space occupied by each passenger upon the longitudinal seats of street surface railroad cars, according to measurements taken by the commission's inspectors in 800 different cases. The adoption of the standard became necessary for the guidance of the commission's inspectors in determining the proportion of car seats available to the number of passengers carried.

Field and Office

Steel-Tape Repairs

Probably most engineers and surveyors repair their own steel tapes. The repair outfit, consisting of a combined punch and rivet set and copper rivets or eyelets, is almost always part of the equipment of a surveyor's office, and the cleaning and mending of tapes is usually a regular rainy-day occupation for such of the field assistants who have not yet attained proficiency in drafting and computing.

From the experience of Fred W. and John E. Kelly, of Seattle, Wash., manufacturers of tape-repair outfits and specialists in making tape repairs, it would seem that few surveyors' assistants know how to repair a broken tape properly, even when furnished with all the necessary facilities. From information furnished by the Kelly brothers and from a great many samples of tape repairs submitted by them, the following comments have been prepared.

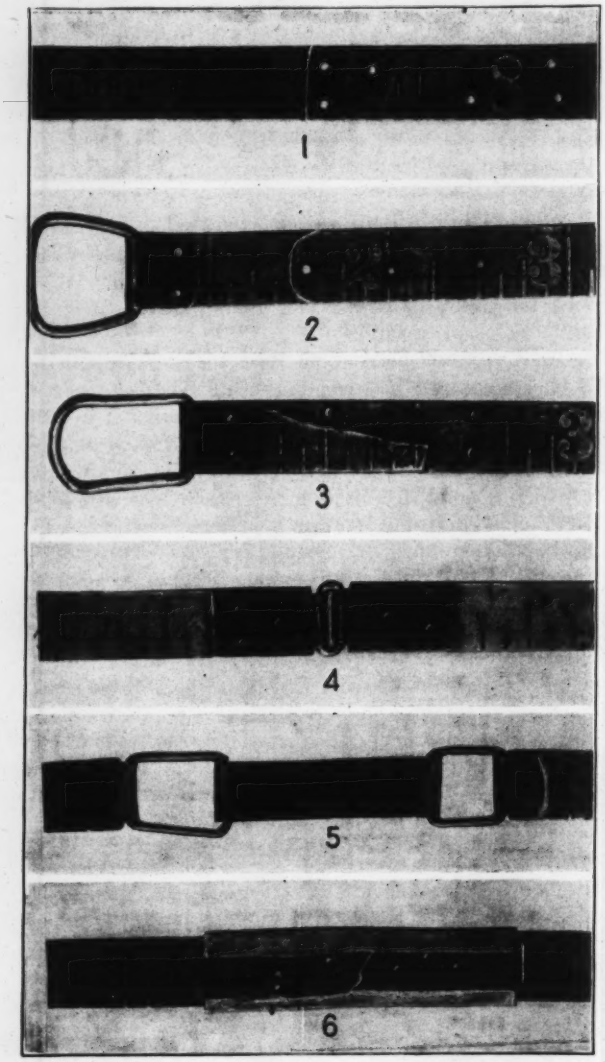


FIG. 1. "HORRIBLE EXAMPLES" OF TAPE REPAIRS

The point which needs the most emphasis is that no matter how the tape is broken, some of the original tape must be cut away and a new piece spliced in. This applies both to graduated ribbon tapes and to most of the heavier flat-wire tapes. Any kind of a mend which stiffens the tape at the splice weakens it and makes it more likely to break near there a second time, especially in the case of thin ribbon tapes. The only exception is in the case of heavy wire tapes, ⅛-in. wide or less, which are usually so stiff that they can be mended with a soldered sleeve.

In Fig. 1, tapes Nos. 1, 2 and 3 illustrate defective splices. No. 1 is made by lapping the tape by 0.12 ft. and securing the lap with six eyelets. A little reasoning would have shown that two eyelets and a 0.02-ft. lap would have done just as well. This is one end of a 0.3-ft. splice, and the tape broke a second time at the left-hand end of the splice. No. 2 is another lap joint, 0.1 ft. long. In No. 3 the whole of the old tape has been retained and the repair made by riveting a piece 0.15 ft. long on the back; solid rivets are used where eyelets should have been. Nos. 2 and 3 also illustrate defective methods of fastening on the end rings. The lap is too long. The best result is attained if the lap is little more than 0.1 ft., fastened with two eyelets. Nos. 4 and 5 show conscientious and ingenious attempts to keep flexibility, but by means not to be recommended. No. 6 is a crude but effective repair, no doubt made in camp. The sleeve was probably cut from a tin can and an axe and nail were used for a punch. There are no rivets and the sleeve holds by depressions punched partly through the tape.

In Fig. 2 is illustrated the proper way to make tape repairs according to directions: First punch two holes in each of the broken ends about 1 in. or more back from the break. Take a piece of tape about 2 in. longer than the completed splice is to be, lay one of the broken ends on the splice, tying it tightly to insure proper alignment, and punch holes in the splice through the holes already punched in the tape, placing and setting a rivet as soon as a hole is punched. Solid rivets are used for flat-wire or band tapes, and when the tape is ¼ in. or less wide, the rivets are placed in tandem, as shown in No. 1, Fig. 2. When the splice has been riveted to one end of the broken tape, lay the other broken end on it, and butting the two ends of the break together, tie it in place and rivet as before. When all the rivets are driven, notch the ends of the tape close to the rivets with an edged file and break the tape on the file marks. In the same manner notch and break off the ends of the splice close to the rivets. The result is a lap of not over 0.03 ft. for a tandem splice and a little over 0.01 ft. (or ⅛ in.) for rivets side by side, which means a tape practically as flexible as new. For thin ribbon tapes eyelets should always be used instead of solid rivets, as shown in Nos. 3 and 4, Fig. 2.

To replace a broken ring or repair a tape broken at the ring, take a piece of similar tape showing any foot

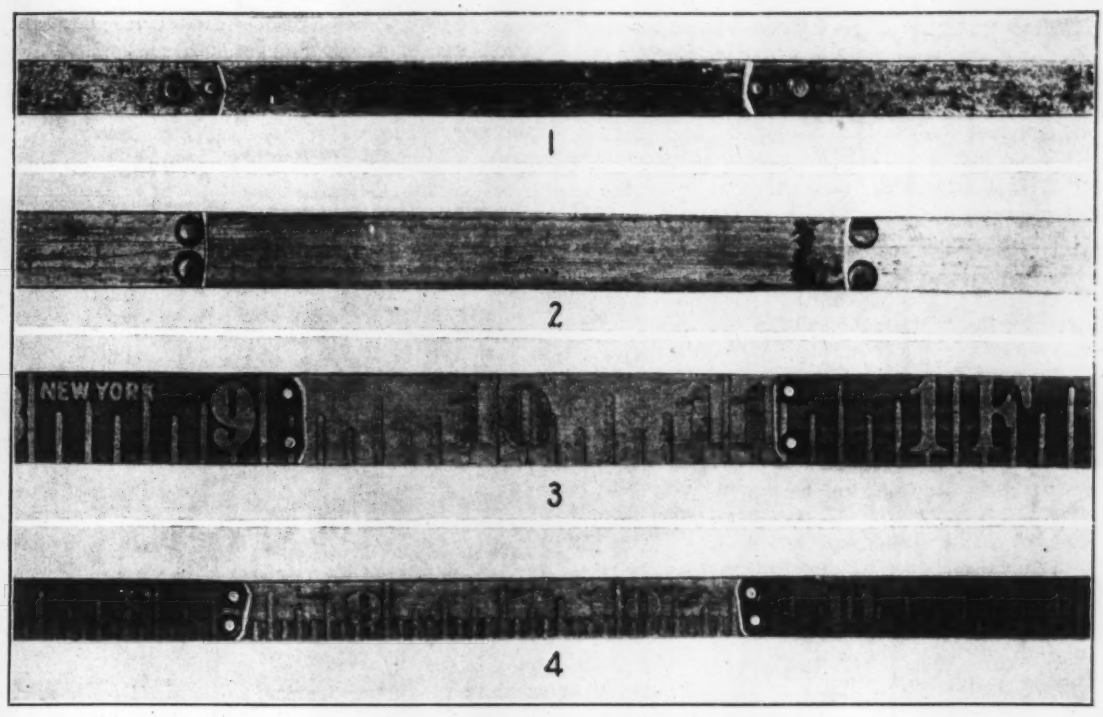


FIG. 2. EXAMPLES OF TAPES REPAIRED TO PRESERVE MAXIMUM FLEXIBILITY

mark. Lay the ring with its clip or sleeve in place on this splice-tape, and hold it there by slipping a narrow piece of tape (or a wire) under the splice-tape and over the ring (see Fig. 3). Punch one hole through the ring clip and tape, separate, and cut the tape close to the hole; insert the clip and rivet, using a long eyelet. Then punch the second hole and rivet as before. Notch the clip with

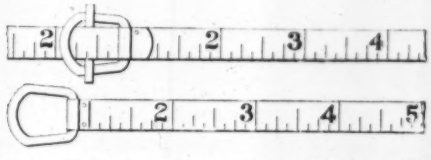


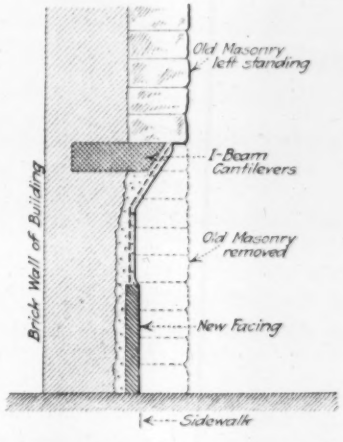
FIG. 3. HOW TO PUT THE RING END ON A TAPE

a file close to the eyelets and break it off on both sides of the tape. Rivet the new section to the broken end, not less than 2½ in., or 0.2 ft., from the end, being careful to lay the new piece on top of the old tape.

Alterations to Chicago Buildings

Alterations are being made in the first-floor fronts of several of the older office buildings in Chicago, partly to remove decorative or structural work encroaching upon the sidewalk line (as required by the city) and partly to give increased shop-front space. In the former case outside stairways have been shifted back into the buildings and porticos, columns, etc., removed or trimmed down. Where the batter of heavy masonry walls extended beyond the building line the masonry has been dressed to a vertical face, or in some cases the original masonry has been replaced by steel columns and lintels.

At the Postal-Telegraph Building (the old Rialto Building) the main entrance on Van Buren St. had massive piers of quarry-faced masonry supporting a portal arch and heavy decorative work above. All this was outside the building line, as shown in the accompanying drawing. To eliminate sidewalk obstruction, one of the masonry courses of each pier was drilled and broken out. Jacks and blocking were placed to support the super-



REMOVING DECORATIVE MASONRY THAT ENCROACHED UPON SIDEWALK; POSTAL BUILDING, CHICAGO

structure, while a pair of I-beam cantilevers was inserted in each pier. After these were in place the lower part of each pier was removed, leaving the arch and upper decorative work supported on the cantilever brackets.

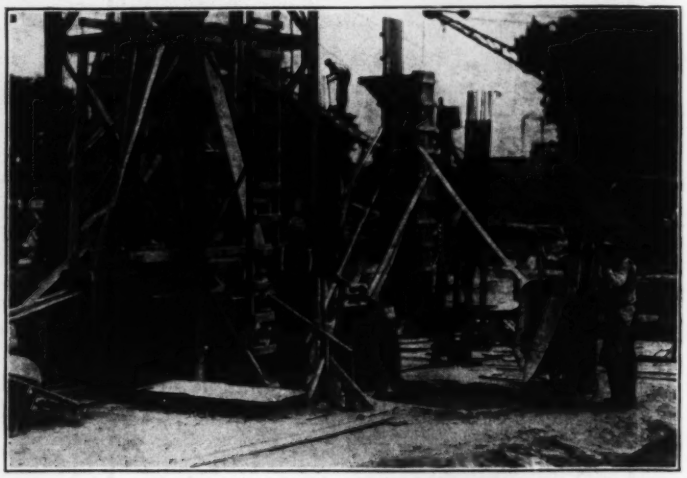
A brick facing was built for the lower part of the new work, then a network of reinforcing bars was placed and concrete filled in to cover the broken face of the old masonry and the ends of the cantilevers.

A similar crusade against building encroachments in lower Broadway and Fifth Ave., New York City, in 1912 and 1913 required some very expensive changes of the fronts of several prominent buildings.

Concreting Plant with One-Man Control

An efficient concreting plant is in use on the new assembling plant for the Ford Motor Co. at Louisville, Ky. The mixer, a ⅓-yd. Smith, is located below ground level alongside the base of an Insley tower, and both mixer and hoist are driven from the same engine. The feed-hopper platform, shown in the accompanying view, is on a level with a near-by railway switch on which cars carrying material are brought in and the material dumped in piles near the tower. Materials are brought from the piles by wheelbarrows and dumped into the feed-hopper shown in the foreground. Alongside of this feed-hopper are two levers operated by one man. One lever controls the feed gate and the other the discharge gate of the mixer. On the level below and within reaching distance is the water-pipe valve and a signal wire that leads to the engine. Thus, the one man shown in the center of the view controls the whole mixing and hoisting operations.

With this plant a batch can be made every 22 sec. with a labor cost of 28c. a cu.yd. The plant was devised by E. A. Thompson, Superintendent for the contractor, the W. E. Wood Co., of Detroit, Mich.



One-Man Control of Concrete Mixer

Method of Erecting Marconi Masts

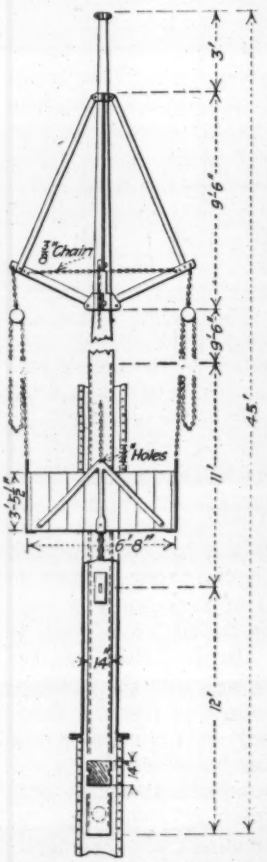
By L. H. Peebles*

Erecting a tubular Marconi radio mast is an interesting and rapid performance. Ten stations have recently been built by the J. G. White Engineering Corporation, involving 79 masts varying in height from 300 to 500 ft. The mast sections are built up of steel half-cylinders or quarter-cylinders made from flat steel plates, horizontal and vertical bolting-flanges being pressed from the flat plate when the section is shaped. As a rule, the half-cylinder sections are 10 ft. long and the quarter-cylinder sections 15 ft. long. The transmitting masts are a trifle higher than the receiving masts and are of larger diameter throughout the lower portion.

These masts have a wooden topmast, ordinarily 14x14 in. by 23 to 30 ft. This is used as a ginpole during erection. The steel sections of the mast itself have a ½-in diaphragm plate in each horizontal joint. The plate is made in halves, notched to go around the erection pole.

At station No. 4, Marshall, Calif., seven 300-ft. masts were erected. The method used in erecting one of these masts—a receiving mast composed of 54 half-cylinders 24 in. in diameter, which is described in what is to follow—represents the typical procedure. The foundation is of concrete, 10 ft. square by 6 ft. deep. The four anchorages are 10-ft. concrete cubes, 150 ft. from the mast foot.

In erecting, a half-cylinder is first bolted to a steel bedplate shimmed up from the foundation, the concrete of the foundation having been left down 1 ft. below the plate to give room for bolting on the first cylinder. The plate is fastened to the foundation by anchor bolts. After the first half-cylinder is in place the topmast is set inside and guyed. The topmast hoisting cable, 60 ft. long, is laid in the grooves in the mast (see drawing), where it remains until all the steel has been erected. One end of this cable is attached to a hook, which bolts to the top horizontal flange of the steel cylinder. The cable runs from the hook down to the foot of the wood mast and over a sheave there and up the mast and is lashed at a point where it will not interfere with the placing of the opposite half-cylinder, which is now raised and bolted both to the bedplate and to the adjacent half-cylinder. The next two half sections are then placed on top of the cylinder just erected, the vertical joints being staggered 90 deg.



Erection Outfit for Marconi Masts

A sheave mounted on a pedestal is then bolted to the top of the last half section raised, directly in line with one of the cable grooves in the topmast. The hook on one end of the topmast hoisting cable is moved to the top flange of the cylinder last erected, and there bolted. The run of the topmast hoisting cable is now down from the hook, through the sheave at the bottom of the topmast and up the side of the mast to the sheave on the flange of the cylinder last erected, down to a pulley at the foot of the steel mast, and over to one drum of the hoisting engine.

The topmast is held in its successive positions during

*Engineer, J. G. White Engineering Corporation, 43 Exchange Pl., New York City.

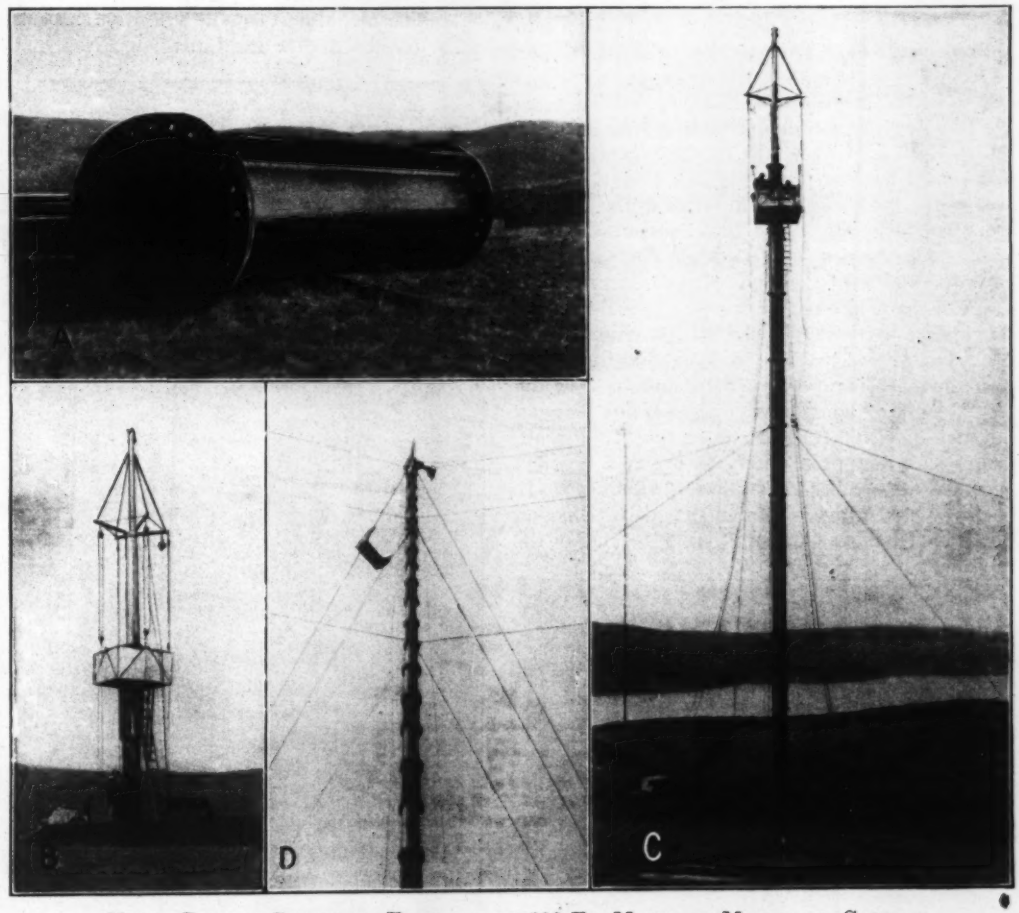
erection by a pin known as a fid. Near the base of the topmast there is a hole approximately 1¼x3¼ in., which pierces the mast, and at the top of each steel cylinder there is a corresponding hole. When the topmast is raised to a new working position a fid is passed through the cylinder and topmast, thus anchoring the latter.

When the first cylinder has been erected, the concrete foundation is continued up to a point 1 ft. above the bedplate. The interior of the cylinder is then filled with a good cement grout to the bottom of the fid hole. Water in the cylinder thus drains from the fid hole.

The next step is the rigging of the erection cage, which is 6 ft. 8 in. square, built in halves fitted around the mast and securely bolted together. It is supported by steel arms attached to a collar on the topmast and is raised by four 1-ton chain blocks, each with 120 ft. of chain, all as shown in the drawing. After bolting up the two half-cylinders the first operation in raising the erection outfit to a new position is to hoist the topmast. During this operation the cage is anchored by chains attached to the top flange of the last cylinder erected. The chain blocks from the mast crossarms are let out as the topmast is raised. When the topmast is anchored in its new position, the chain blocks are tightened and the cage anchors detached. The workmen raise themselves and the cage by means of the chain blocks. The next pair of half-cylinders is then raised and placed in position about the topmast. The material line, which raises the sections, operates through a pulley attached to the outer end of one of the angle-iron cage supports and leads through a pulley at the mast foot to the second drum of the hoisting engine.

When all the steelwork has been erected, the topmast is securely wedged into the top cylinder. The crossarm is attached with its insulators and pulleys, and the ½-in.-diameter permanent top cable is attached to a pulley at the head of the topmast and lashed at the top of the steelwork. A 620-ft. steel cable is passed through a pulley attached to the topmast near the crossarm and reaches to the ground doubled. Both these lines remain permanently on the mast and afford means for reaching the top.

When the top cylinder has been erected, the position of the cage is just below the top set of guy cables, to which the cage is fastened at the guy attachments. In dismantling the cage, the chain blocks are removed and the angle-iron cage supports are disconnected and lowered to the ground. The bolts holding together the halves of the cage are replaced by loose pins attached to the hoisting line by means of cables and pulleys. This is accomplished in such a manner that when ready to lower the cage these pins slip out automatically and the cage falls apart, as shown in view D.



VIEWS DURING COURSE OF ERECTION OF 300-FT. MASTS AT MARSHALL, CALIF.

(A, Cylindrical section with diaphragm plate attached. B, Starting erection; erection topmast and cage rigged. C, Mast up 100 ft. D, Mast completed; lowering erection cage)

During the erection of these particular masts the weather conditions were severe. Gales of 90 mi. per hr., as registered at the Point Reyes Station of the U. S. Weather Bureau, made the work especially hazardous.

The cylinders were given one complete coat of paint in the shop. Two inside coats and one outside coat were applied in the field before erection, and a second outside coat afterward. It was found most satisfactory to have two members of the erecting crew paint the masts immediately after erection, working from a scaffold operated by the hoisting engine. In the meantime the other members of the crew attended to the moving of the erection outfit to the next mast, the hoisting engine being shifted last.

The main advantage of this type of mast is the short time required to erect. This is the principal factor wherein a saving in cost can be shown. So far as weight and cost of material are concerned, the probabilities are that there is very little advantage in this type over the structural-steel self-supporting mast. This general type was first designed by Marconi's Wireless Telegraph Co., Ltd., London, England, and with slight modifications has been used very successfully by the Marconi Wireless Telegraph Co. of America, and associate companies.

No falsework whatsoever is used in the erection of the Marconi type of mast, and to give an idea of the short time required to erect a mast complete, the J. G. White forces, at Bolinas, Calif., erected one of the 300-ft. masts, attached all guys, dismantled the cage and secured the topmast in 28 working hours, with a force of one foreman and eight men. A 400-ft. mast at station 7, Marion, Mass., was erected in approximately 35 hr. by a foreman and 11 men. A 500-ft. mast at station 9, Kahuku, H. I., was erected in 72 hr. by a foreman and 12 men. Erection in the Hawaiian Islands took a longer time because of the class of labor used. First-class riggers were not available, and a cosmopolitan lot of Japanese, Russians and Kanakas were employed. It is worthy of note that in the erection of the 79 masts at these ten stations, not a man was seriously injured.

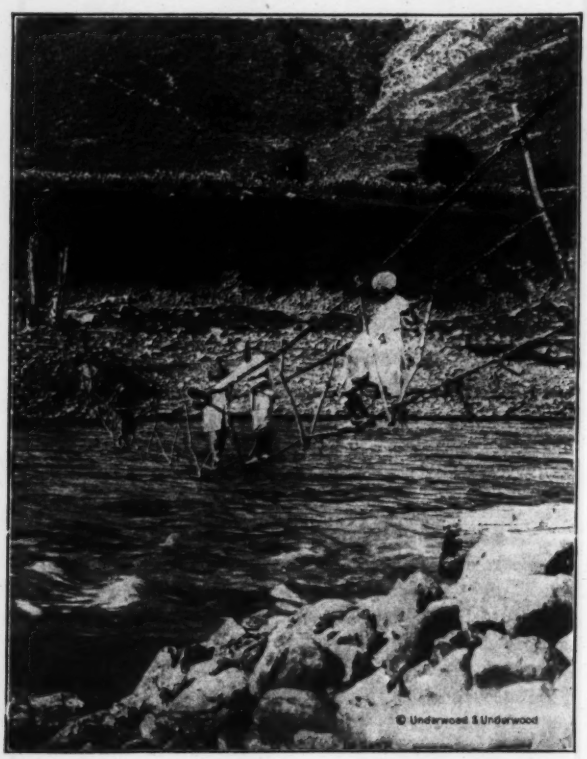


FIG. 1. AN INDIAN FOOTBRIDGE

Two Simple Suspension Bridges

The three-rope suspension footbridge shown in Fig. 1 is across the Jhelum River in northern India. It is mainly interesting on account of the simplicity of the floor and the remarkable uniformity of the spreaders, which though of natural growth are of practically the same angle and size throughout the bridge.

Another and almost equally primitive suspension bridge is the one built over the Canadian River in Oklahoma.

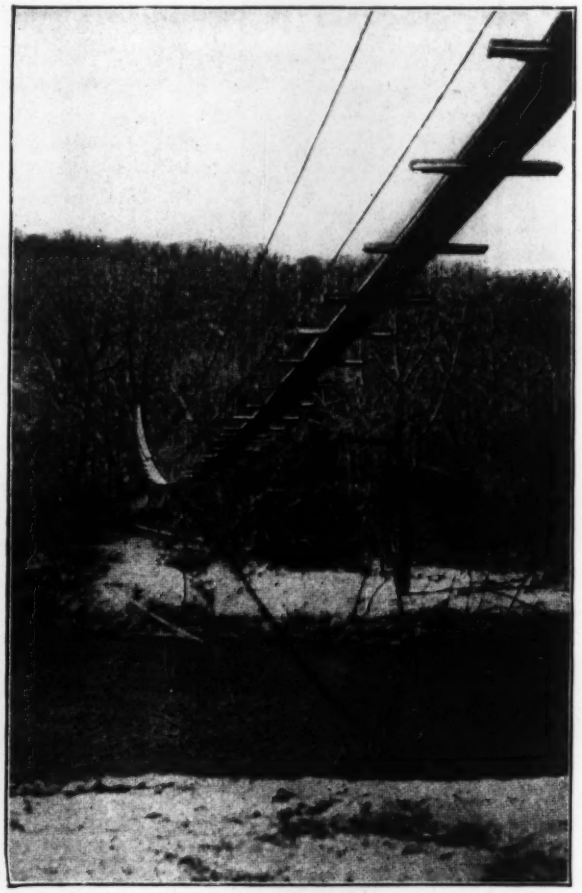


FIG. 2. SUSPENSION BRIDGE OVER CANADIAN RIVER, OKLAHOMA

This bridge (Fig. 2), however, has an elaborate floor system as compared with that of the Hindoo structure. The Oklahoma bridge is hung between two trees. It was built by "line walkers" whose duty it is to inspect the main trunk pipe-line of the Gulf Refining Co.

Ripping Up Street Railway Tracks

Since October, 1913, the San Antonio (Texas) Traction Co. has had to rebuild practically all the tracks in the downtown section because of the paving program adopted by the city, which was mentioned in our issue

of Dec. 10, 1914, p. 1176. Some of the tracks torn up were 60-lb. T-rail in gravel ballast, while others were 6-in. 74-lb. and 7-in. 98-lb. grooved girder rail laid on wood ties in concrete. The 98-lb. rail was in good condition and was used in the reconstruction of the track, while the other tracks were replaced with 6⅞-in. 87-lb. or 92-lb. girder rail.

In reconstruction (except at special work) steel ties were used. These are 6 in. long by 3 in. deep, with a 5-in. upper flange and a 3-in. lower flange, and are spaced 4½ or 5 in. c. to c., except at joints, where they are spaced on 2-in. centers.

In tearing out 60-lb. gravel-ballasted track, jack-pits were dug opposite each other under each rail and spaced about 15 or 20 ft. apart. The track was jacked up by the use of one 15-ton jack per rail. As the track was raised men with sledge hammers knocked the cross-ties clear of the rail. This work was described by G. W. Smith, of the San Antonio Traction Co., at the eleventh annual convention of the Southwestern Electrical & Gas Association.

In the case of the section with the concrete bed, where wood ties had been used, jack-pits were dug opposite each other under each third tie. Six 15-ton jacks were placed in consecutive jack-pits and the whole mass of rails, ties and concrete was raised 6 or 8 in. and blocked up on large pieces of broken concrete, rock or old ties. Drill-pointed chisels, made from 1½-in. octagonal steel, and 12-lb. sledge hammers were used to break up the concrete. The large pieces of concrete were hauled to a storage yard for future use in concrete construction where steel ties are used.

Another Simple and Efficient Recording Gage for Weir Measurements

By David E. Adams and Earl I. Roberts*

We are now using in Columbus, Ohio, a device for the measurement of sewage flow similar to that described in Engineering News, Apr. 29, 1915, which we think offers several advantages over the one employed by the Massachusetts State Department of Health.

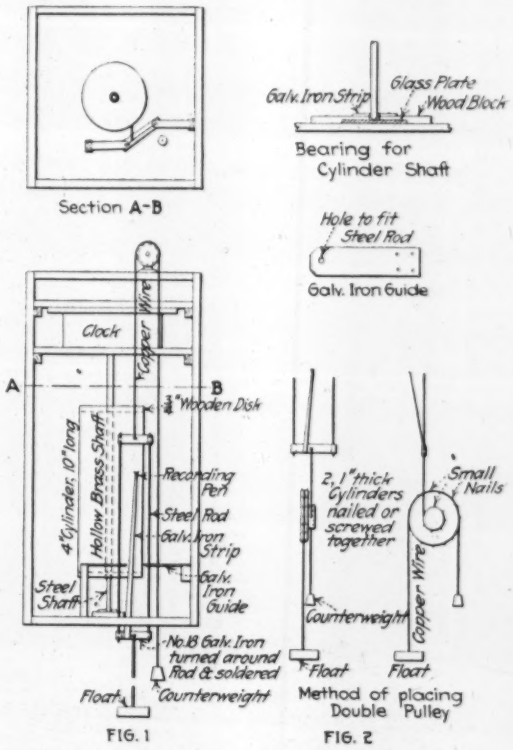
The City of Columbus is having made a sewerage survey under the direction of Prof. F. H. Eno, of the Ohio State University, and while employed upon this work as inspectors, the writers designed and built the gage described herewith.

Our original intention was to build a gage for the measurement of the dry-weather sewage flow only and for use with metal weirs, which had been placed in various sewers of the city, but we are now using these gages also for the measurement of storm flow, and they are giving excellent service.

The gage consists of a wooden float covered with galvanized iron, to which is attached a framework of two small steel rods connected by galvanized-iron strips, which carries the recording pen. To the upper end of this framework is attached a cord running over a pulley above and carrying a counterweight. The cylindrical drum carrying the record is covered with thin galvanized iron and is driven by an 8-day double-spring clock manufactured by Seth Thomas, Thomaston, Conn. The record sheet is fastened on the drum by rubber bands at the top and bottom.

The framework carrying the pen is prevented from moving laterally by means of guide strips, in which holes to fit the steel rods are made, and also by means of the counterweight. The bearing for the drum is made as shown in the drawing by the use of a small glass plate. The shaft carrying the drum is fixed rigidly to the clock and is geared so as to make one revolution in 12 hours.

The whole apparatus is built in one box, and holes are cut in the top and bottom to allow for the float wire and counterweight cord. In the gage used by the Massachusetts Department of Health the recording pencil is carried on a rod which in turn is guided in its vertical motion by a small arm moving in a slot. The rod to the float must not be too long, or its weight would prevent the free working of the float; hence, if it were desired to install the gage in a manhole, say 10 ft. above the level of the sewage, there would probably be some difficulty in its working.



Details of Columbus Recording Sewage Gage

As gages of this type record the actual variation in the flow or head, the cylinder must be of such height as to cover this variation. In order to measure greater variations without the use of a very high cylinder (as during a storm), we have used an auxiliary double-pulley arrangement, as shown in Fig. 2. This requires the use of another small counterweight, but it has worked very satisfactorily. By this arrangement the range of the cylinder may be increased according to the ratio of the circumferences of the pulley rings.

The advantages claimed for this gage are: (1) It is extremely simple and easy to build; (2) by means of adjusting the length of the float wire it may be installed at any height above the flow line; (3) the gage is covered

*Ohio State University, Columbus, Ohio

and thereby protected when placed beneath a perforated manhole cover; (4) its cost is low; (5) it may be easily installed in sewers, sump holes or open streams.

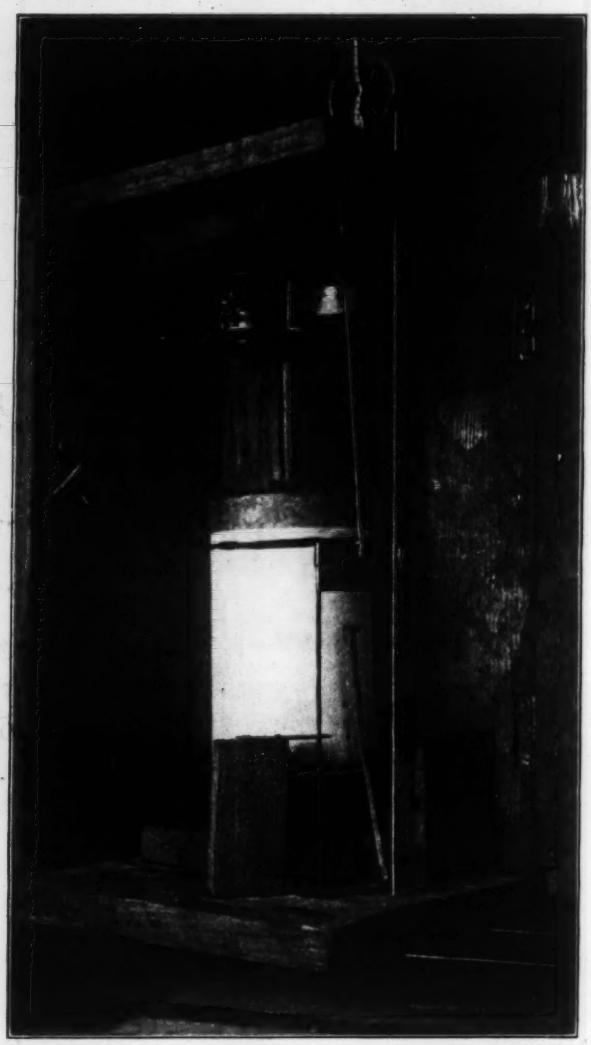


FIG. 3. HOME-MADE RECORDING GAGE USED FOR SEWERAGE SURVEY OF COLUMBUS, OHIO

Throughout the last summer we operated continuously two of these gages, and no trouble was experienced with them. The material, including the clock, should not cost more than $8, and it can be built by anyone.

NOTES

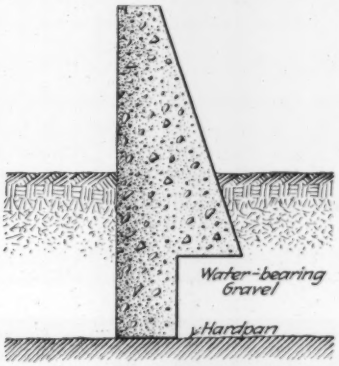
Use of Concrete Piles—An inquiry as to the practice and experience of numerous railways in the use of concrete piles has been made by the masonry committee of the American Railway Engineering Association, and the summary of its review of the information obtained is substantially as follows:

The piles are usually reinforced, but plain concrete piles have been used in several cases. There is a large variance in the amount of steel reinforcement used, both longitudinal and transverse. The greater portion of the piles have ¼-in. rods for transverse reinforcement, whether spiraled or hooped. Steel mesh is used in a few cases, and in one case additional steel reinforcement is used in the head of the pile. The weight of steel per linear foot of pile ranges from 4.25 lb. on the C., B. & Q. R.R. to 12.5 lb. on the Illinois Central and 17½ lb. on the C., M. & St. P. Ry.

The piles are usually of 16-in. short diameter, whether square or octagonal. The A., T. & S. F. Ry. varies the short diameter, using the formula D = 7 in. + ¼-in. L., where L. equals length of pile in feet. Straight piles are used more than those of tapering section.

Pumping with a Boat Motor was employed in sinking a well shaft for the Milwaukee Western Malting Co. The motor, which was built by the Evinrude Motor Co., of Milwaukee, is made to hook over the stern of a rowboat or scow, its vertical shaft being geared to a propeller shaft ("Engineering News," Nov. 19, 1914). In this case the vertical shaft was coupled directly to the shaft of a small centrifugal pump, submerged in the sump, and having a capacity of 50 gal. per min. with 10 ft. head.

An Unusual Highway-Bridge Abutment—In building a bridge abutment in water-bearing gravel where scour was to be apprehended, Willis Whited, Bridge Engineer of the Pennsylvania State Highway Department, resorted to the design shown in the accompanying illustration as a cheap and effective solution of the problem. Instead of extending the whole abutment down beyond the water-bearing stratum,



BRIDGE ABUTMENT IN WATER-BEARING GRAVEL

a cutoff wall was built on the face of the abutment to the full depth and the rest of the abutment carried down only far enough to be below frost action and to give a firm bearing. The sketch illustrates the principle, but not the actual dimensions.

Record Maps of New York Water-Supply Distribution System—For general use as wall maps and for the use of foremen and others in the field, tracings to a scale of 400 ft. to the inch have been prepared, showing by symbol size of mains, connections, valves, hydrants, blowoffs, etc. Street lines are omitted except in outlying sections, as the mains indicate the streets and the additional lines are confusing. These maps are kept up to date, and prints in the repair companies' headquarters are corrected each month as far as practicable. The boundaries of services are shown by colors. Atlases to scales of 100 and 160 ft. to an inch have been tried to record actual locations of mains, valves, hydrants and appurtenances, with depth of cover, when laid, etc. These have not been a success and it is considered that drawings to a scale of 40 ft. to an inch will be more suitable, with a scale of 20 ft. used where there are very complicated intersections. On the large scales can be shown location of taps as well as other details.—W. W. Brush, in a paper before the American Water Works Association, March "Bulletin," 1915.

High Compressive Strength of Glass—Compression tests on glass made a few years ago at Watertown Arsenal showed remarkably high strength. Samples 4x2x1 in. tested on end showed strengths from 52,000 to over 77,000 lb. per sq.in. for rough plate glass, and 45,000 to 84,000 lb. per sq.in. for polished plate glass. A test on a much larger specimen was made recently at the Bureau of Standards. A cube nearly 10 in. on a side was tested in compression. At relatively low loading the outer shell of the cube, ½-in. thick or so, spalled off. The remainder of the cube was not seriously injured, however. The load was run up to the capacity of the machine, 2,400,000 lb., without breaking the specimen. The load at this time amounted to about 30,000 lb. per sq.in To supplement these surprisingly high figures of the crushing strength of brittle material we have a remarkable test of encaustic tile 6x6 in. tested on edge, on a base approximately 6x½ in., showing a strength of 50,000 to 61,260 lb. per sq.in., as reported in Tests of Metals 1895.

Editorials

Water Waste and Mayoral Ignorance

The great waste of water in Chicago has again been brought to public notice, this time by the report of a board of engineers appointed by the Chicago Real Estate Board to inquire into the water-supply and sewerage systems. The new mayor's quoted comment on this report is: "We are glad to have lots of water and waste it, for it makes Chicago a cleaner and healthier city. I doubt if Chicago's water-supply could be improved by cutting down the quantity and filtering the remainder."

Surely in these days of public knowledge concerning technical and scientific matters, such utterances as this of the mayor's should not pass unchallenged. The idea that a high water consumption is an index of a city's cleanliness or healthfulness is old; but it is an idea not supported by facts. The official reports of Chicago's own engineers in the city service show that from 30 to 50% of all the water pumped in Chicago is wasted. That means that leaking faucets and water-closets and carelessness in the use of water cause a lot of the water which has been pumped from the lake to run into the sewers unused. Such wasted water does not make the city nor its people any cleaner and does not furnish any protection against disease. On the other hand, the cost of pumping this wasted water represents an enormous outlay, which, if it were intelligently expended, could accomplish a great deal in protecting the health of the city. Besides this, the waste of water causes low pressure in many parts of the city, where the mains are inadequate, and this water shortage may cause unflushed water-closets and other offenses against cleanliness and health, besides seriously affecting the city's protection against fire.

These are facts easily demonstrable to any intelligent person, and the mayor of a great city ought to be informed as to these facts and not mislead the public with the exploded idea that water waste makes the city any cleaner or healthier.

Proposed Street-Railway Survey at Baltimore

Congestion of street cars on some of the business thoroughfares of Baltimore has led to propositions for rerouting several lines of cars. Certain petitions for diverting lines from one street to another were recently reported on by Calvin W. Hendrick, Consulting Engineer to the Board of Estimates of Baltimore. In concluding his report on the specific propositions which are now to the front Mr. Hendrick suggested the need for a broad coöperative survey of the whole subject, with the idea of formulating a working plan for some years to come. We quote this portion of Mr. Hendrick's report, which is as follows:

> As conditions in the city are reaching a stage where matters of this kind will be constantly coming up, I think it would be highly desirable for the Board of Estimates, the Public Service Commission and the United Railways officials to begin a comprehensive survey of the problem from the standpoint of the city as a whole, not with a view to making an immediate report, but to be prepared to have the situation well in hand, so that when questions of diversion and congestion arise they will be in a position to meet the conditions promptly, both as to present and future conditions.

This is sound advice. A few cities and a few street-railway companies have made surveys of their street-railway service, and many others might well follow suit.

The proposition for a triangular survey—by the city, the local railway interests and the Public Service Commission—has some strong points. Too often—in fact, almost invariably—such studies are made by only one of the parties in interest. In the past the street-railway companies have done very much as they chose, both in laying out track and in routing cars. The public is now beginning to see that it has a vital interest in all such matters. It is not yet wholly awake to the situation. Its interest is too spasmodic, too sectional or local and too selfish. When it does wake up, for a time it is prone to forget that proper consideration should be given to the interests of the street-railway company. Mr. Hendrick's proposal to bring the city and the company together to study these problems and to add the Public Service Commission as a sort of umpire has much to commend it.

Selling Stock in Patent Railway Tie Companies

The arrest in Pittsburgh recently by United States postal inspectors of the officers of the U. S. Steel Railway Tie Co. for selling stock in an alleged $25,000,000 corporation calls attention to the frauds which have been carried on recently in various parts of the country in the exploiting of patents on railway ties. The vigilance of the United States Post Office authorities has to a large extent done away with the old plan of selling stocks in wildcat corporations through the mails by means of flaring newspaper advertisements.

The business is therefore carried on in a different way. Stock is sold directly by agents to credulous people, usually of small means, and where they have not the money to purchase, stock may be traded for homes or farms. The patent railway tie proposition appears to be a favorite one with which to convince the unwary. It is easy to show on paper a profit of millions from the royalties on the remarkable new patent tie which so and so has invented, and for which such and such a great railway company is about to place a large order.

We would say no word to discourage the honest inventor or engineer who is intelligently striving to develop any improvement in railway ties of steel or reinforced-concrete construction. It seems necessary to say, however, for the information of any of our readers who may have knowledge of frauds of this sort being carried on in their neighborhood that inventors have been working on railway ties of steel and reinforced-concrete for more

than a quarter of a century. Many of these inventors have been thoroughly familiar with all the practical requirements of railway service and many of these ties have actually been tried in service to a greater or less extent.

The net result in the United States at the present time is that one steel tie—that made by the Carnegie Co.—is in commercial use on the railway owned by that company and to a very limited extent on a few other railways. There are not to exceed a dozen other steel and concrete ties in an extremely limited experimental use. Most of these ties have proved inferior to the wooden tie, while others which have given fairly satisfactory service seem impossible of use for commercial reasons. These facts ought to be known to the men and women who are tempted to buy stock in patent railway tie concerns in the hope of reaping a fortune thereby.

The Standard Barrel Law

Among the curious pieces of legislation enacted by the last Congress is an act "to fix the standard barrel for fruit, vegetables, and other dry commodities." Some criticism may be made of the wording of the title, since one might judge from a literal reading that the standard barrel needed to have its hoops tightened or its bung driven home, or a few knot holes plugged! It may be assumed, however, that what the drafter of this law intended was to fix the *size* of the standard barrel. It further seems to be the case, as one reads between the lines of the law, that the real intent of the act was to fix the size of barrels used in marketing apples, pears, potatoes, onions, and other fruits and vegetables.

Unfortunately, in the desire to make the law all-embracing, the framer of the act added the words "other dry commodities." The law as enacted states the dimensions which the standard barrel shall have, qualifies the statement by the provision that a barrel of any shape having a capacity of 7056 cu.in. shall be a standard barrel, and then declares that it shall be unlawful "to sell a barrel containing fruits or vegetables or any other dry commodity of less capacity than the standard barrel. Any person guilty of a willful violation of this act shall be liable to a fine not to exceed $500 or imprisonment not to exceed six months."

A notable exception in the law is the fixing of a larger-sized standard barrel for use only in the shipment of cranberries. The particular barrel which the law evidently was meant to standardize for all dry commodities other than cranberries is what is commonly known as a flour barrel, the size of which is already standardized, we believe, by a law fixing the weight of flour which a barrel shall contain. Doubtless, the framer of this law did not know that the standard barrel used for sugar shipments, of which hundreds are used for every barrel used for shipping cranberries, is considerably larger than the standard flour barrel. If it was wise to exempt the few barrels used for cranberries, why not exempt the vast number used for sugar?

Again, the framer of the law doubtless knew nothing as to the vast number of barrels used in shipping cement and lime, which are certainly "dry commodities." In the lime industry the use of the standard barrel would greatly unsettle the trade, which now uses different-sized barrels in different sections of the country, according to the weight of lime produced. The difference in the weight of lime is so great that the standard barrel fixed by the law would hold in one section of the country only 225 lb. of lime and in another section 285 lb. Thus, the purchaser of a barrel of lime receives much more nearly a uniform amount now than he will if the new law is enforced.

About the only meritorious feature of the new law is that it does not go into effect until July 1, 1916. There is plenty of time, therefore, for the next Congress to undo the work of the last by repealing this particular piece of foolish interference with business.

If the experts of the Bureau of Standards and the Department of Agriculture find that there is some real need for standardization of the barrel used for fruit and vegetable shipments, such a standard might be legalized, but there is no reason why such a law should be made to apply to the sale and shipment of "all other dry commodities."

Laying Concrete Pavements in Sioux City

The paper in this issue, by T. H. Johnson, Assistant City Engineer of Sioux City, Ia., describing the methods adopted in laying concrete roads and pavements in Sioux City, will be read with interest by every engineer interested in this field of work. That Sioux City has already some 30 miles of streets paved with concrete and expects to lay 25 miles more during the present season is good evidence that concrete paving as there laid is a success.

The principal feature in which Sioux City practice in laying concrete pavement differs from the usual practice elsewhere is in the application of a dry mix of equal parts of cement and sand to the surface of the concrete after it has been laid, brought to the proper crown and floated. A similar method has long been in general use in finishing concrete sidewalks, except that in sidewalk work neat cement is generally used to dust over the top to make it dry enough for the finisher to trowel smooth. It is true that when the troweling is overdone a layer of neat cement is formed on the surface and crazing takes place. Using a dry mix of sand and cement should offset this danger and should give the pavement a dense and uniform surface.

This application of the dry mixture to the surface of the wet concrete overcomes one of the chief practical difficulties in the laying of concrete roads and pavements. If the concrete is mixed wet enough so that it will compact well without forming voids, it is apt to be so wet that in floating the pavement smooth, surplus water comes to the surface in such quantity as to prevent first-class work. By adopting the Sioux City plan of sprinkling a dry mix on the wet concrete, the latter can be mixed wet enough so that it will run freely through the pipe of the distributor and spread easily on the subgrade. Voids in the concrete will not occur with such a wet mix; and if the surplus water is absorbed by the dry material there is no chance of trouble from laitance. It is to be noted that this dry mix is spread immediately after floating the concrete, so that there is no chance for the concrete to take any initial set before the dry mix is applied.

It is particularly noteworthy that by the use of this dry mix to give a firm, smooth, wear-resisting top coating, Sioux City is able to use for its concrete roads a

much leaner mixture than that ordinarily considered necessary, to wit, 1 : 2½ : 4, instead of the 1 : 1½ : 3 now generally specified for concrete roads. This means, of course, a material saving in cost. That this lean mixture has not resulted harmfully is indicated by Mr. Johnson's statement that not 2% of the 25-ft. concrete blocks in Sioux City's 30 miles of pavement have developed cracks in service. It may be worth while suggesting that possibly Sioux City could make a still further improvement in its concrete-paving practice by adding a percentage of hydrated lime, both to the body of the pavement and to the dry mix, as is now being successfully done on the concrete roads of Maryland.

Oiling Streets and Roads

A newspaper scribe in the Middle West prints an item headed "City Streets Will Be Oiled—Oil Man Is Being Seen Today by Local Layers of the Lubricant."

Whether the reference to the oil as a lubricant was due to the headline writer's fondness for alliteration, or is really descriptive of the oil, is not clear; but, unfortunately, lubricating oil is the proper term by which to describe much of that which unwise city and town officials are using as a dust layer on streets and roads.

The present practice of oiling street and road surfaces grew out of the use of crude California petroleum on Los Angeles county roads. This original experience was successful because the California petroleums have an asphaltic base, and after the lighter oils have evaporated leave the dust and earth or gravel cemented into a compact crust. Most of the crude petroleums of the East and their distillates have paraffin bases and are lubricants rather than road binders. While their use as temporary binders and dust layers has been defended, experience has proved over and over again that any road oil is of value in direct proportion to the amount of asphalt (or bitumen in tar products) which it contains.

A complete knowledge of the character and qualities of various asphaltic and tar road oils and binders is probably beyond the comprehension of the average city or town road official, if indeed any one is quite able to grasp it, but the essential difference between lubricating oil and binder oil ought to be known.

The application of lubricating oil to a street surface inevitably means a nasty mess, greasy and sticky with every rain, so long as the oil lasts, and a greasy irritating dust which spots clothing and everything else, as soon as the oil dries out a bit, which does not take long on hot summer days.

Water or calcium chloride is a thousand times to be preferred to "lubricating" oil for laying dust; but if oil is decided upon, every man entrusted by the public with the care of streets and highways ought to have enough technical knowledge to be able to distinguish between lubricating oil and road oil.

Letters to the Editor

Back-Filling Trenches: Cheapness vs. Efficiency

Sir—I have read with special interest the article on p. 941 of your issue of May 13 on the subject of "Cheap and Effective Back-Filling with a Road Roller." I am pleased that the word "effective," rather than "efficient," is used in the title. If there is anything which does not contribute to "economy and efficiency" in connection with road construction it is back-filling by throwing the material into trenches in large masses, whether by tip cart, horse scraper, steam shovel, trenching machines, or the steam-roller "pusher," which I understand from the description to be practically a plowshare operated by a steam roller at the end of a long pole or tongue.

Undoubtedly this, from the point of view of *cheapness* only, is an "effective" method of getting 75% of the excavated material back into a trench and leaving the remainder either piled up over the trench, distributed over the entire surface of the street, or hauled away, with the result that in a few weeks there will be a settlement over the trench.

I cannot refrain from entering my protest against all methods of back-filling which similarly disregard solidity of the fill. In this matter most particularly, as is a general rule in most forms of construction, cheapness is generally the opposite of economy, as effectiveness may be the opposite of efficiency.

In back-filling trenches the rule should be not how fast or cheaply can the dirt be put in the trench until it is full, but how solidly can it be replaced—or, in other words, how can the dirt be put back, with none left over in excess of the volume taken up by the pipe and without raising the grade of roadway surface.

In the particular case referred to, the conditions may have been such that it was unimportant whether or not the trench subsequently settled. However, there is perhaps no other thing contributing more to the expense of building and maintaining pavements and roads than this very simple but very much abused matter of properly back-filling trenches.

Like "proper drainage," the "back-filling" of trenches is a matter on the importance of which, as an essential prerequisite to successful road construction and economic maintenance, nearly every engineer agrees; but it is about the last thing he will provide for in his specifications, or enforce.

GEORGE C. WARREN,
President, Warren Brothers Co.

Boston, Mass., May 21, 1915.

Tension on Rivets

Sir—All books for structural engineers assume that the only stress to be resisted by rivets is shear. A few writers casually warn the reader that direct tension in rivets must be avoided. A few specifications contain a clause forbidding the use of rivets to resist tensile stresses. Since the main reliance of students is a textbook supplemented with personal instruction from a teacher, it is disconcert-

ing to young fellows to find that in many shops rivets are used to resist direct tensile stress.

The case against tensile use of rivets is stated as follows by Morris ("Steel Structures," 3rd ed., p. 25), who goes further than most writers in discussing the matter:

> The amount of the initial tensile stress on the rivets is a very uncertain quantity. It sometimes requires a very little pull on the head of a rivet to break it off. This is probably in part due to the heat treatment which it has received, making it nonhomogeneous. Nearly all specifications prohibit the use of rivets in direct tension, but they are nevertheless so used in certain connections, because the construction is usual and simple. In these connections there are usually stresses acting at right angles to each other, such as a shearing and a tensile stress. Bolts might be used to take the tension and rivets to take the shear, but rivets are generally used throughout.

A coal telpher plant was installed some time ago in a Western city power plant. The rail at the switch joint was suspended by four rivets. Computations made on the basis of the rivets being equal to bolts in tension showed the connection as apparently strong enough. The rivets broke the second day after the plant was put in operation. New rivets were put in, and as they lasted usually only a couple of days, bolts were substituted. The bolts would last a week or two, so the operator kept extra bolts in his pocket and when the rail showed signs of being loose he climbed up and put in a new bolt. This went on for several months, when one day the fastening gave way and the operator was crushed beneath his car. His widow sued and was awarded damages. The power company then sued the manufacturer.

On the witness stand the writer held out strongly for the statement that rivets were not proper to use in such a place and that bolts were superior, but that even bolts there were not proper. The jury decided that, no matter what opinions might be given by engineers, the fact that rivets held only a day or two and bolts a week or two was enough to prove to them that bolts were superior to rivets (the bolts undoubtedly gave way because they were highly overstressed, not alone by the direct load, but also by impact and the moment caused by the overhang of the end of the rail close to the switch joint). The judge instructed the jury to render a verdict against the manufacturer because he had guaranteed to protect the purchaser against all defects in material and workmanship for a period of one year and the accident had occurred within the period of the guarantee. The manufacturers, therefore, had to pay the expenses of two lawsuits and reimburse the power company for the damages paid to the widow.

The writer, in testifying, had stated that to use rivets for direct tensile stress in such a position was an unpardonable sin and that the man who believed such a connection a proper one was to blame for any deaths that might occur through any designer following his advice or instructions. He was asked to give authorities and found it difficult on short notice to find any, because of the silence of books on the subject. He managed to find some specifications which were considered to be all right. The manufacturer was unable to find an engineer to take the opposite view on the stand.

A few days ago the writer had his attention called to a statement in Burt's "Steel Construction," p. 64, which takes the opposite view:

> It was formerly the custom to specify that rivets should not be subjected to tension, but that bolts should be used in such situations. This provision was necessary when wrought-iron rivets were in use, as their heads could be easily broken off. Steel rivets are much more reliable in this respect and, if properly driven, can be subjected to tension as safely as bolts.

Had the engineers for the manufacturer known of this book at the time of the trial, it probably would have been introduced to discredit the evidence of the writer and show that to use rivets in direct tension is *not* an unpardonable sin. The writer therefore calls for the views of the readers of ENGINEERING NEWS, so we may know whether the book expresses the opinion of one man or really is representative of changed conditions and ideas.

ERNEST MCCULLOUGH.

Chicago, Ill., May 20, 1915.

Government Competition with Private Engineers

Sir—A letter by Hugh C. Mitchell in ENGINEERING NEWS, May 6, under the title, "Competition of the U. S. Geological Survey with Private Engineering Practice," makes allusion to an arrangement between the U. S. Geological Survey and the Tallahatchie Drainage District in Mississippi for topographic surveys.

It is not proposed here to offer comments upon the subject-matter of Mr. Mitchell's letter but to give the facts and considerations upon which the contract between the Survey and the drainage district was based. The writer was then Chief Engineer of the drainage district, and was the instrumentality through which the arrangement was effected.

The Tallahatchie Drainage District was organized by authority of an act of the Mississippi legislature in February, 1908. The district covers an area of 1,150,000 acres in the northern part of the Yazoo basin.

The U. S. Geological Survey is engaged in a general and comprehensive survey for the purpose of covering the whole territory of the United States with a system of topographic maps. This task, from the nature of the case, is very slow of accomplishment. It was the Survey officers who made the proposal to the officials of the drainage district that the territory embraced in the district be so surveyed at that time as to serve to the mutual advantage of both parties, each party to pay half.

As the Survey was prepared to put into the field promptly a sufficient number of survey parties, fully equipped and trained in that kind of work, their proposal appealed very favorably to the drainage district officials, and the contract was made, the signing of which by the governor of the state was done at the instance of the U. S. Geological Survey.

Through the joint efforts of the Survey and the district engineers the whole area was practically covered by topographic surveys, including a comprehensive system of precise levels and permanent benchmarks. Also a vast amount of essential data was accumulated, such as rainfall observations at about 30 stations properly distributed, water-gage records, stream gagings, run-off observations, cross-section of channels, profiles, etc., the work covering a period of about three years.

Although this promising drainage project "went to smash," for the time being at least, by reason of maladministration by an incompetent board of drainage commissioners appointed by the governor of the state, yet these valuable records have been preserved by the special endeavor of the writer.

T. G. DABNEY.

Clarksdale, Miss., May 26, 1915.

Austin Lord Bowman

Austin Lord Bowman, Chief Engineer of the New York City Department of Bridges, and a former director of the American Society of Civil Engineers, died June 3, at his home in New York City. He was born in Manchester, N. H., 54 years ago, and was graduated from Yale University with the degree of B.A. in 1883.

From 1885 to 1886 Mr. Bowman was employed on the construction of the Kings County Elevated R.R. of

A. L. Bowman

Brooklyn, N. Y. He then went West and for four years was in railway work, both location and construction, with the Chicago, St. Paul & Kansas City R.R. and the Norfolk & Western Ry.

Following his railway experience he joined the engineering staff of the American Bridge & Iron Co., Roanoke, Va., as Engineer and Superintendent of Construction. In 1897 he entered the service of the United States Government and built the snag boat "Roanoke." He also had charge of raising two large schooners sunk in 80 ft. of water in Hampton Roads, Virginia.

For the 10 years previous to his connection with the city of New York's Department of Bridges Mr. Bowman was in private practice as a consulting engineer, specializing in bridge and heavy construction work; and during this period he had direct supervision of the reconstruction of many of the bridges of the Central R.R. of New Jersey.

In 1907 he became Consulting Engineer of the Department of Bridges of New York and in July, 1914, was appointed Chief Engineer of the Department of Bridges and served in that capacity until his death.

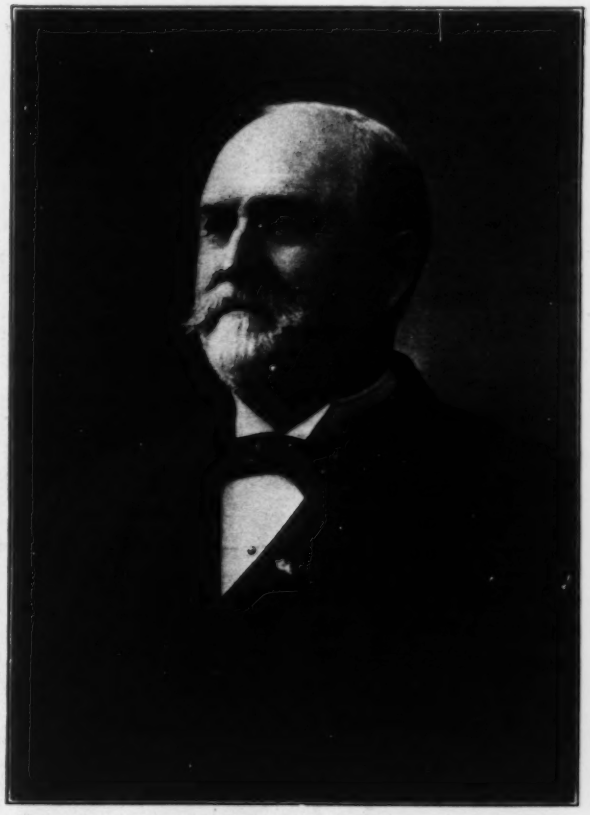
Mr. Bowman was a member of the American Society of Civil Engineers, the American Society of Mechanical Engineers, the American Society for Testing Materials, the American Railway Engineering Association, the American Railway Bridge and Building Association, and the International Association for Testing Materials. He was a director of the American Society of Civil Engineers from 1905 to 1907, and at the time of his death was chairman of one of the society's most important committees, appointed "to consider and report upon the design, ultimate strength and safe working values of steel columns and struts."

He is survived by a widow and a young daughter.

Joseph S. Mundy

Joseph S. Mundy, the well-known builder of hoisting engines, died at his home in Newark on May 26. He had not been entirely well since Christmas. Death resulted from a stroke of apoplexy.

J. S. Mundy was born in Rahway, N. J., on Apr. 24, 1847. His early education was secured in a country district school. In the summer he worked on his father's farm. In 1866 the Mundy family removed to Newark and for a little while young Mundy worked at the stone-cutting trade. The real beginning of his career was in the fall of 1866, when he apprenticed himself to Dutton & Wilson, machinists, at $3 per week. In 1866, when that firm was dissolved, Mundy went with the Hicks Engine Co., and one year later bought an interest in the firm of Horton & Kent, successors to the Dutton firm. In 1870 he bought the entire business, and from that time



JOSEPH S. MUNDY

to 1875 his principal interest was the developing of the friction-drum hoisting engine, which was accomplished in the latter year.

Mr. Mundy's interest for the past year had been centered in the erection of a new plant on Frelinghuysen Ave., Newark. It is expected that the equipment will be moved from the old factory to the new by August of this year.

Steel Suburban Passenger Cars for the Erie R.R.

The Erie R.R. has just put into service on one of its suburban passenger lines running out of Jersey City a train of steel passenger cars, which are of especial interest because their dead weight has been so reduced that they weigh no more than the old wooden equipment.

There is no doubt that the steel passenger car is the car of the future. The greater safety of passengers in wrecks in properly designed steel cars is alone sufficient to dictate their use, and there is a strong tendency to make their adoption compulsory by Federal and state legislation. This is so well understood that the building of wooden passenger cars has practically ceased and all new equipment is of steel.

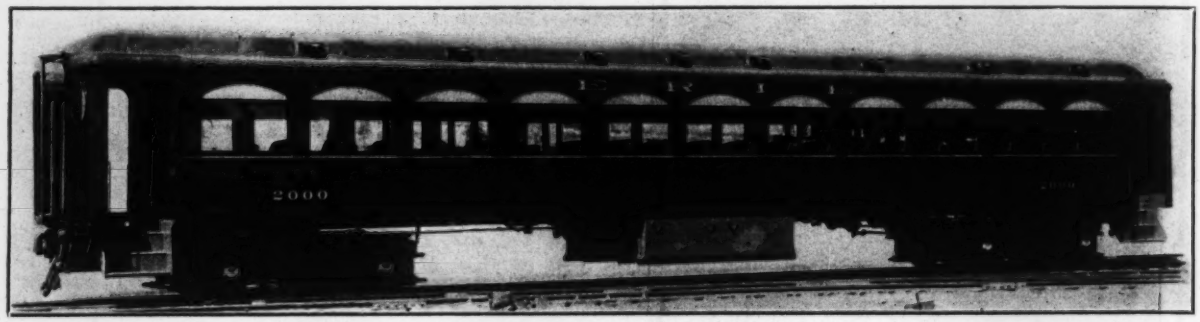


FIG. 1. STEEL PASSENGER COACH; ERIE R.R.

FIG. 2. PRESSED-STEEL TRUSS FRAMING FOR ERIE STEEL COACH

A very serious drawback in the use of steel rolling stock is its weight. Most of the steel cars now in service are much heavier than the wooden cars which they displace. This additional weight is a source of expense from the time the car is put into service until it finally lands in the scrap heap. Every additional pound of weight in a railway car requires power to accelerate it every time the car is put in motion or its speed is increased, and must be hoisted up every upgrade that the car ascends. Again, the inertia of this weight when once in motion must be overcome by grinding up brake-shoes and carwheel treads every time the train slackens speed or runs down a grade. Besides this, the excessive weight of heavy rolling stock means—as every engineer in charge of track maintenance realizes—accelerated wear on rails and ties and additional expense for track maintenance.

There is a current idea that the heavier car is safer for the passengers in the event of collision or derailment. Of course cars should be substantially built, but it must be remembered that weight itself is undesirable from the standpoint of safety. The heavier the car, the greater is the stored up force to cause crushing and damage in a train accident. If, therefore, it is possible—as these new Erie cars appear to demonstrate—to build steel cars which shall not exceed in weight the old wooden cars, and still secure ample strength for the protection of passengers in the event of collision, the matter is one of great importance in connection with railway operation.

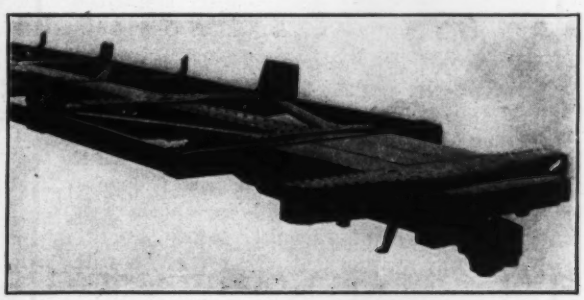


FIG. 3. VIEW OF STEEL UNDERFRAME, SHOWING PLATFORM AND BUFFER CONSTRUCTION

It is claimed for the new Erie cars that they are in reality stronger to resist shock in collisions and derailments than the types of steel cars hitherto built. This has been accomplished by the design of the car superstructure, and especially of the ends of the car, as hereinafter explained.

The general plans for the car have had the personal attention of President Underwood of the Erie, and the

detail designs have been worked out under the supervision of William Schlafge, General Mechanical Superintendent, by L. B. Stillwell, Consulting Engineer, and Mr. Stillwell's associate, Frank M. Brinckerhoff.

In general, the plan adopted in the design is to make each side of the car a steel truss. The two trusses being rigidly braced together at the top and bottom by the car floor and roof, the whole structure forms a rigid framework. It is thus the car body which carries the load of the car, considered as a bridge spanning the distance between the truck bearings, and not the car underframe. The car center sills are of light construction compared with the sills generally used on steel cars. As the deflection of these sills under load would be very much greater than that of the truss, it is evident that the truss and not the sills will carry most of the car loading. The center sill, however, is relied upon to resist buffing stresses and is held rigidly in line by its connection to the superstructure so that buckling cannot occur.

This type of steel car framing is really a further development of the system worked out by Mr. Stillwell and his associates some years ago in designing the cars for the New York, Westchester & Boston R.R. and described in ENGINEERING NEWS of June 12, 1913, p. 1213. In the new Erie cars, however, the system has been applied to a longer car body, and the absence of a center door in the side of the car has facilitated the construction.

FIG. 4. TRUCK FOR STEEL PASSENGER COACH

If it were not for the necessary provision of windows in the car sides, it would be the simplest matter in the world to make each side of a car body a perfect truss, with the lower chord at the bottom, the upper or compression chord at the top, and diagonal members between them. The narrow space between the windows, however, prohibits the use of diagonal members extending from top to bottom. The framework on each side of the car is made up of a series of pressed-steel units, which are shown in the accompanying drawing. As there seen, the vertical posts, running from top to bottom, are 10-in. pressed channels ¼ in. in thickness. They are braced with diagonals below the windows and with flanged gussets at the top. Of course that part of the post above the window level has to withstand shearing stresses, which become considerable toward the body bolsters forming the points of support. Reinforcing members are riveted to the posts where the stresses make this necessary.

The question which naturally arises is as to the strength of this construction to resist buffing and collision stresses. The manner in which these stresses are carried is explained as follows: The central sill of these cars is built up of two 8-in. 16.25-lb. channels spaced 14 in. back to back. These are connected at the top by a 19x⅜-in. cover plate, and the bottom flanges of the channels are reinforced by 4x3½x⅜-in. angles. The total cross-section of this center sill is 22 sq.in. of metal. Beyond the body bolster at each end these center sills are reinforced by pressed-steel draft sills, which add 10 sq.in. additional to the metal cross-section. The end posts of the car vestibules are 9-in. I-beams which frame into the car sills and the vestibule ceiling construction. The ends of the car body have pressed-steel corner posts 12 in. deep, strongly riveted by gusset connections to the side sills and to side plates. The roof framing is

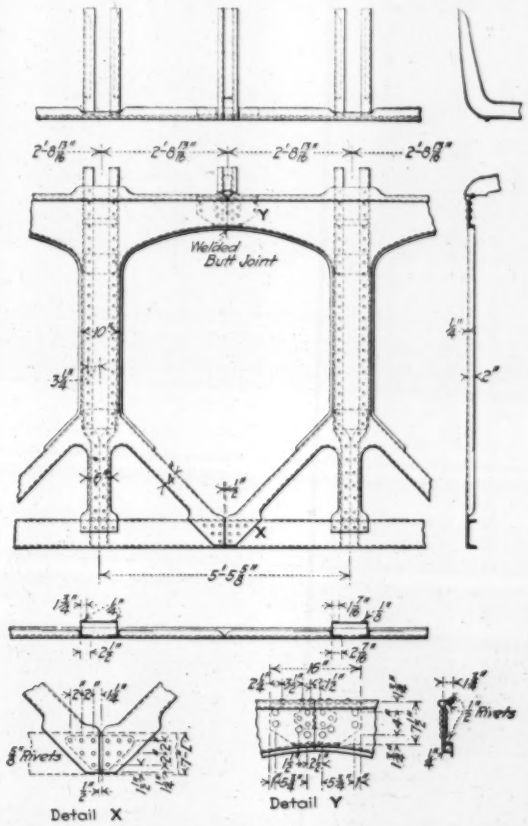


FIG. 5. PART OF STEEL FRAMING FOR SIDE TRUSS

of pressed channel car lines of compound-arch form. The whole car superstructure is designed with the idea that the car frame will resist collapse even should the car be overturned.

The table at the bottom of the page shows the weight of the cars in comparison with the weight, capacity, etc., of various other classes of steel underframe and wooden passenger cars now in use on the Erie R.R. It will be seen that the weight per foot length of car is substantially the

WEIGHTS OF VARIOUS TYPES OF PASSENGER COACHES, ERIE R.R.

	New Cars, All Steel	Class 1935-1950, Steel Underframe	Class 1911-1934, Steel Underframe	Class 1825-1874, Wood	Class 1800-1824, Wood
Number of seats	86	72	72	72	72
Average weight of car, lb.	95,400	96,500	100,500	83,200	86,600
Weight per seated passenger, lb.	1,100	1,340	1,400	1,140	1,200
Weight of lighting equipment, lb.	8,000	8,000	8,000	Gas 2,000	Axle Gen. 6,500
Net weight of car, exclusive of lighting	87,400	88,500	92,500	81,200	80,100
Weight per seated passenger, exclusive of lighting equipment	1,017	1,230	1,284	1,128	1,112
Length over all	70 ft. 4 in.	66 ft. 3½ in.	66 ft. 3½ in.	66 ft. 3½ in.	66 ft. 3½ in.
Weight per foot of overall length, exclusive of lighting equipment	1,243	1,333	1,395	1,225	1,210

same as that of the old wooden equipment, as stated in the foregoing.

In the design of these cars the possibilities of the future application of electric motive power to them was taken into consideration. The reduction in the depth of the center sill is especially favorable for the use of electric motors, and the cars have been so designed that electric motors can be applied to them with practically no structural change. The roof of the car has also been designed of sufficient strength to support a pantograph current collector.

Special attention has also been given to the design of the car trucks to secure easy riding. The trucks, complete with brake rigging, weigh 12,500 lb. each. Instead of using springs over equalizer bars, the trucks are fitted with springs over the journal boxes and long quadruple elliptic springs under the bolsters. The use of journal-box springs causes the entire weight of the truck frame to be spring-supported. Clasp brakes are fitted, eliminating side strain on the journals in brake application and reducing chattering of the brakes. Coleman bolster locking center pins prevent the separation of the car body from the truck in case of derailment or collision.

The cars are lit by eleven 25-watt electric lamps mounted in the center of the car and furnished with current from an axle generator and storage battery.

Deterioration of Steel Bridges over Railway Tracks at Buffalo

By R. J. Reidpath*

SYNOPSIS—The results of an investigation into the steel bridge over railway tracks at Buffalo, N. Y., and the design of a new bridge to replace one nearly destroyed by corrosive gases from locomotives.

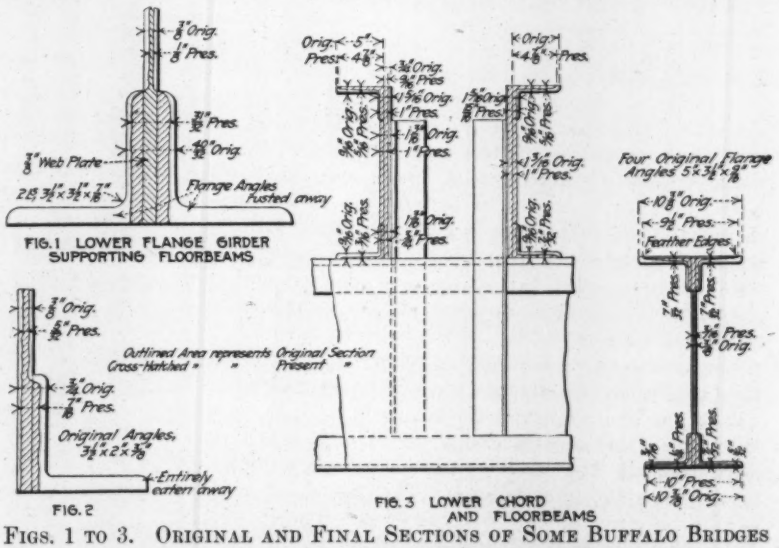
About twenty years ago the City of Buffalo began to build, at enormous cost, a number of viaducts and bridges to carry streets over dangerous railroad crossings. It was the intention to spare no reasonable expense to make the best possible structures at that time. As it was before the era of concrete they were built of steel and if they had received proper care they should have stood for many years to come. Following contracts made between the city and the railroad companies, the cost of the structures was paid for by the contracting parties according to their agreed proportionate benefits. After the structures were completed, by agreement between the railways and a non-technical commission of citizens appointed to represent the city, the sole cost of their maintenance in the future was to be borne by the city and all obligations of the railroad companies were at an end.

Under the conditions of the contracts the Department of Public Works has done all that could be done to prevent the deterioration of the structures and maintain them in a safe condition, but it was hampered in its efforts through the lack of sufficient appropriations. That the necessary funds for this work were not forthcoming from time to time was owing to the cutting down of desired appropriations by various officials and boards aspiring for future political honors and making political capital, for the time being, out of low tax rates, regardless of consequences in the future. The result is that many of the viaducts have deteriorated to such an extent that contracts are now being let for reconstructing several and rebuilding one entirely new structure 700 ft. in length.

In inspecting these structures and in designing new ones to take their place, a number of interesting details of design and maintenance were developed. These will be described at some length. The inspection was done under considerable difficulty. The floor-beams in all of the bridges, and the lower chords in many, had to be reached from the under side. An engine with a freight car attached was used to reach the various parts of the structures. Certain main members were scraped, cleaned and calipered. Where calipers could not be used, holes were drilled through the members and their exact dimensions obtained. In some of the more important places that could not be satisfactorily examined, the floors and sidewalks had to be removed.

Corrosion from Locomotive Gases

The greatest reduction in the sections of the steel was found where the lower flange angles of the floor-beams and lower chords were subjected to the direct mechanical



FIGS. 1 TO 3. ORIGINAL AND FINAL SECTIONS OF SOME BUFFALO BRIDGES

(Showing in outline the original section and hatched the section remaining after locomotive gas corrosion)

*Robert J. Reidpath & Son, Architects and Engineers, Builders' Exchange, Buffalo, N. Y.

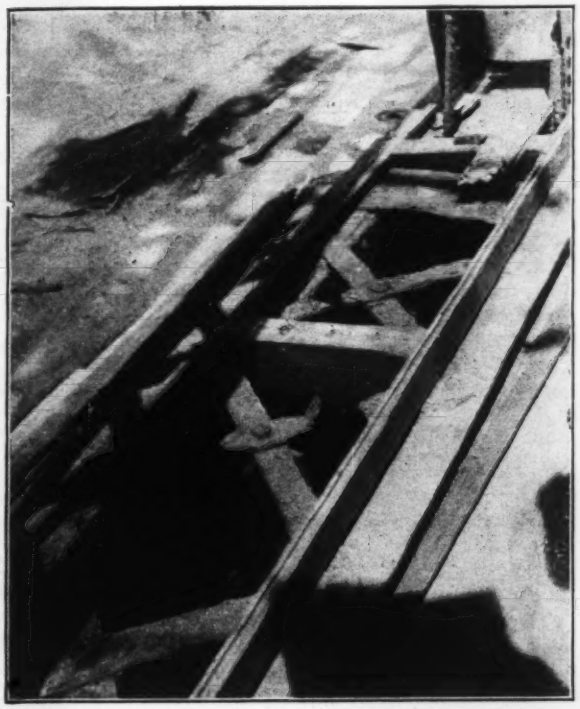


FIG. 4. A CHORD EATEN AWAY BY RUST

and chemical action of the cinders and gases from the locomotives exhausting through their stacks. This action, which had the effect of a sand blast, cut the steel very rapidly and constantly exposed fresh surfaces to the gases and deteriorating effects of the atmosphere. The extremely low headroom over the tracks brought the stacks to within a few inches of the under side of the bridge. For a time a 7/8-in. matched pine shield was tried, but it was not a success, as a few blasts from the exhaust tore it off and the corrosion continued.

Fig. 1 shows an original and a present section of the lower flange of a stringer. The original section was built up of two $3\frac{1}{2}$x$3\frac{1}{2}$x$\frac{7}{16}$-in. angles and a $\frac{7}{16}$-in. web-plate. Fig. 2 shows the original and the present section of a floor-beam. Where the upper side of the horizontal legs of the lower flanges angles are sloped it indicates the loss due to corrosion where the cinders lodged and were continually saturated by condensation from the steam seeping through, depositing the acid from the fumes directly on the steel and retaining it there. The under side of the flange is cut away, showing the action of the blast from the stacks. Fig. 3 shows a section through the bottom flange of a diaphragm, between the floor-beams under the street-car tracks. This loss in section is due, almost entirely, to the action of the blast from the locomotive stacks.

A considerable loss in section took place in the top flanges of the floor-beams, between the bearings of the trough plates where the cinders accumulated in the openings. The heads of a great many of the rivets in the floors were entirely eaten away and as much as 3/8 in. up into the shanks. The lower chords in many places were proportionally reduced in section. They were built up with plates and angles, as shown in Fig. 3. Where cover-plates were used instead of lattice bars on the upper sides of chords they retained the gases to the greater injury of the steel. Fig. 4 shows the condition of some of the lower chords and illustrates how the lattice bars are entirely eaten through.

The upper parts of the structure above the floors were in remarkably good condition, showing that the deterioration of the floor systems and lower chords was due to the direct action of the gases, steam and cinders. The conclusion to be drawn from conditions found is that, with proper attention, the life of the steelwork could have been prolonged for many years and that the parts that needed the most care were inaccessible and received the least attention.

THE CHICAGO STREET VIADUCT

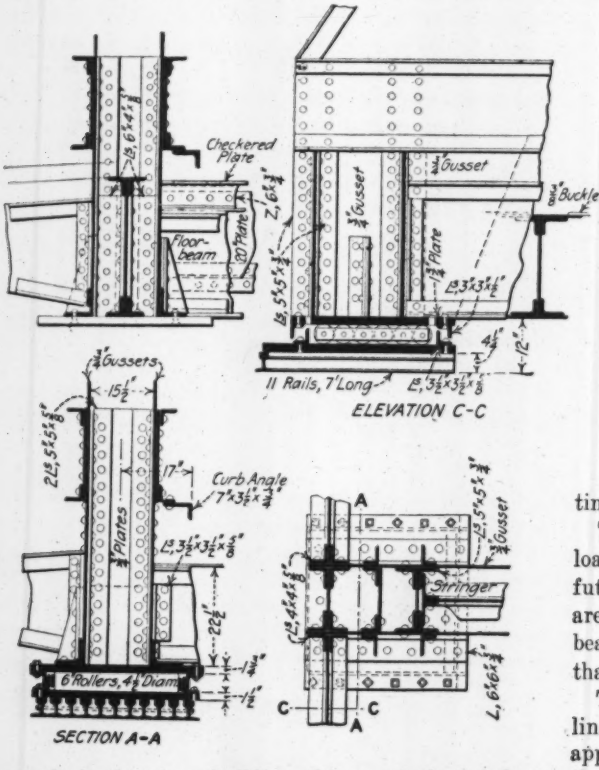
One of the crossings, that at Chicago St., was in such bad condition that it had to be replaced by another viaduct, in the design of which some improvements were made.

The clearance between the top of the railroad tracks and the trusses was fixed and agreed upon in the contract between the City of Buffalo and the railroads. These heights are not sufficient for modern railroad rolling stock, as several times the ventilators have been stripped off the roofs of some of the large parlor and sleeping cars. At the time of the construction of viaducts the subject of grades on the approaches was taken very seriously into consideration, and after many hearings and arguments on the part of merchants and others who had heavy teaming to do over them a minimum grade of 4% was agreed upon. This necessarily affected the length of the ap-

FIG. 5. BRIDGE PIER SPLIT VERTICALLY BY EXPANSION OF SPAN

proaches, and in order to economize in the cost of their construction and consequential damages, the depth of the floors was made as shallow as possible.

In the original design no consideration was given the possibility of greatly increased moving loads in the future.



The result is that in rebuilding this particular viaduct the depth of the floor system is fixed and cannot be increased to an economic or practical depth. The conditions must be taken as they are and met with extraordinarily expensive and unsatisfactory construction.

The clear span of the floor-beams is 42 ft., depth 23 ½ in. and the spacing about 3 ft. 3 in. The arrangement of the tracks in the railroad yards fixed the location of the piers and abutments and determined the length of the spans. These could not be changed, or shorter spans and concrete construction would have been considered. The lower chords have been kept above the roadway, out of reach of the blast from the locomotives exhausting. They are where they can be observed at all times and are accessible for cleaning and painting.

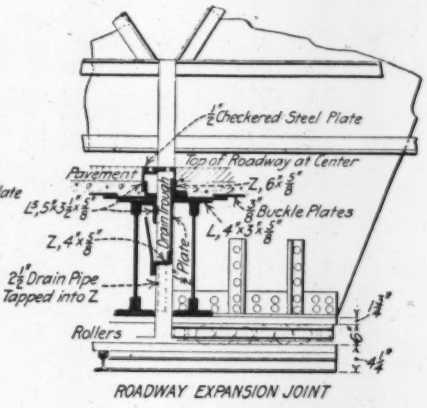
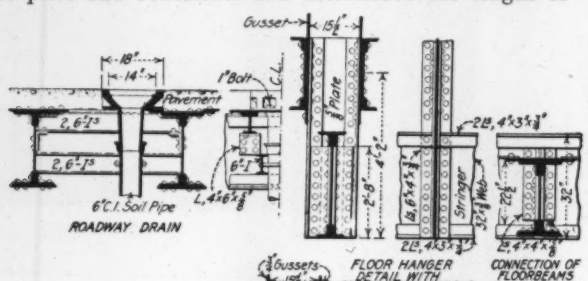


FIG. 6. EXPANSION JOINT ON CHICAGO ST. BRIDGE

The new viaduct has been designed to meet the heaviest loads of modern street traffic, with a fair margin for future increase. The loads assumed for the floor system are four 50-ton trolley cars (concentration on each floor-beam, 12,500 lb.) and 100 lb. per sq.ft. over sidewalks and that portion of roadway not occupied by the cars.

Track loads are assumed as continuous at 2500 lb. per lin.ft. on each track and 100 lb. per sq.ft. of live-load, approaching simultaneously from end to end, covering the bridge and passing off at the opposite end. All moving loads are to be augmented by 25 per cent. of their static equivalent, and provision has been made for wind loads acting in either direction horizontally of 150 lb. per lin.ft. of upper chord.

The entire floor system is suspended from the lower chord at the panel points by a series of hangers, to which are connected a line of stringers running from panel-point to panel-point, directly under the lower chord and extend-



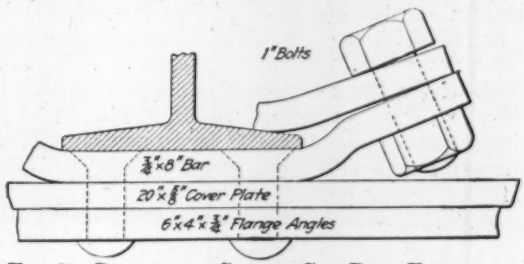


FIG. 7. DETAILS OF STREET-CAR RAIL FASTENERS FOR CHICAGO ST. BRIDGE

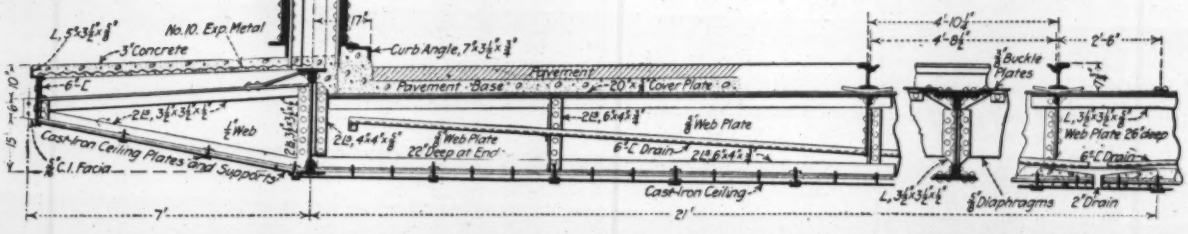


FIG. 8. FLOOR-BEAM DETAILS OF CHICAGO ST. BRIDGE FOR GRADE CROSSING AT BUFFALO, N. Y.

ing the full length of the bridge. This arrangement makes it possible to remove any portion of the floor system without interfering with the trusses.

The floor is of buckle-plates, buckle down, and punched with drain holes. The entire floor is to be calked and made water-tight, except the lines of drip holes in the buckle-plates. Under the lines of holes will be placed a steel channel drain, draining from each side of the roadway to the center, where it is caught in a concrete basin, and from there drained through a hole in the ceiling plate.

Fig. 7 shows the mode of securing the street-car rails. This mode was devised to overcome several objections to the usual mode. The rails could not be secured by bolting them through the floor, as the under side of floor will be inaccessible on account of the ceiling plates and the bolts might become loose and allow water to leak through the floor. Furthermore, with that design difficulties are encountered in reaching the under side of the floor over the track at times when repairs to the tracks have to be made. With the detail shown the tracks can be laid or removed and repairs made from the upper side of the floor.

The under side of the entire structure is to be protected from the locomotive's exhaust by means of a smooth ceiling of cast-iron plates, according to the design shown in Fig. 1, ENGINEERING NEWS, Oct. 15, 1914, p. 764. It was found in examining other structures where cast iron had been used that it had not been seriously affected under conditions where other materials had failed. The plates are so arranged that they can be removed and replaced as occasion may require for painting the floor system, making repairs, etc. They are held in place without the use of bolts or rivets, which in a short time would rust out.

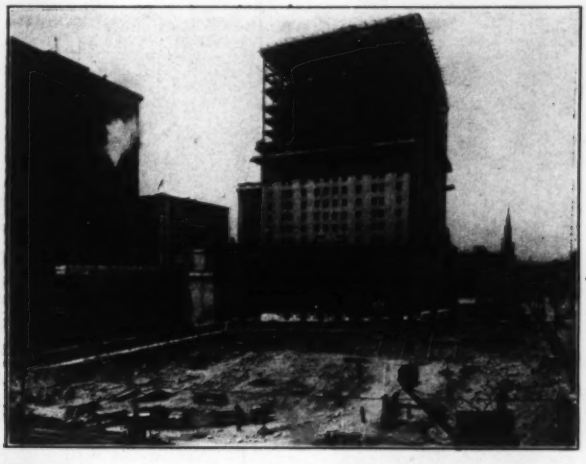
EXPANSION ROLLERS

Some of the expansion rollers in the old bridges were found to be so filled with dirt and rust that they would not operate, and the natural expansion of the spans caused the piers to split (Fig. 5). In order to obviate a repetition of this trouble in the new design, the rollers are to be protected from the weather in such a manner (Fig. 6) that water and dirt cannot get into them. They are also to be filled with semi-fluid grease and provision made for keeping them filled.

News of the Engineering World

Extensive Building Construction in Pittsburgh

The accompanying view shows the present state of two very large buildings now under construction in Pittsburgh, Penn., the property value involved being about $10,000,000. The two jobs are on the old Frick property situated between Fifth and Sixth Ave., Grand St. and Cherry Way, on lots which have long lain idle, although in the very center of the business district of the city. The building practically completed is the 20-story William Penn Hotel. In the vacant lot in the foreground where excavation is now going on is to be the Frick Arcade Building, which is to cover a whole city block and will be one of the largest arcade buildings in the world. The excavation in the Arcade lot is in solid rock, which must be blasted before the steam shovel can be used.



CONSTRUCTION IN PITTSBURGH'S BUSINESS DISTRICT

A Federal Employment Bureau

A Federal employment bureau has been organized by the U. S. Department of Labor, as a part of the Division of Information, for the purpose of developing the welfare of the wage-earners and also of enabling employers to secure such help as they need. Statistics show that there has been in some sections a surplus of labor, while in others there has been a deficiency. It is believed that this condition will be largely eliminated by the bureau.

The country has been divided into 18 sections or zones, in each of which is an employment office. The zones have been subdivided and branch offices opened. The employer can apply to the nearest office for help (skilled or unskilled), and secure what he wants without trouble or expense, making his application in person or by mail. Persons seeking employment can register at these offices, for which no fee is required. In addition, every postmaster is a representative of the employment bureau and has blanks for the use of employers and of persons seeking employment.

These blanks the postmaster forwards to the proper zone office, where help is selected either from local applicants or from the applications on file. A copy of the employer's application is sent to the Division of Information at Washington, D. C. At frequent intervals these applications are assembled and published in the form of bulletins and distributed to all distribution offices, thereby making it possible for each office to know where help of any description is in demand.

A 48-In. Water-Main Break

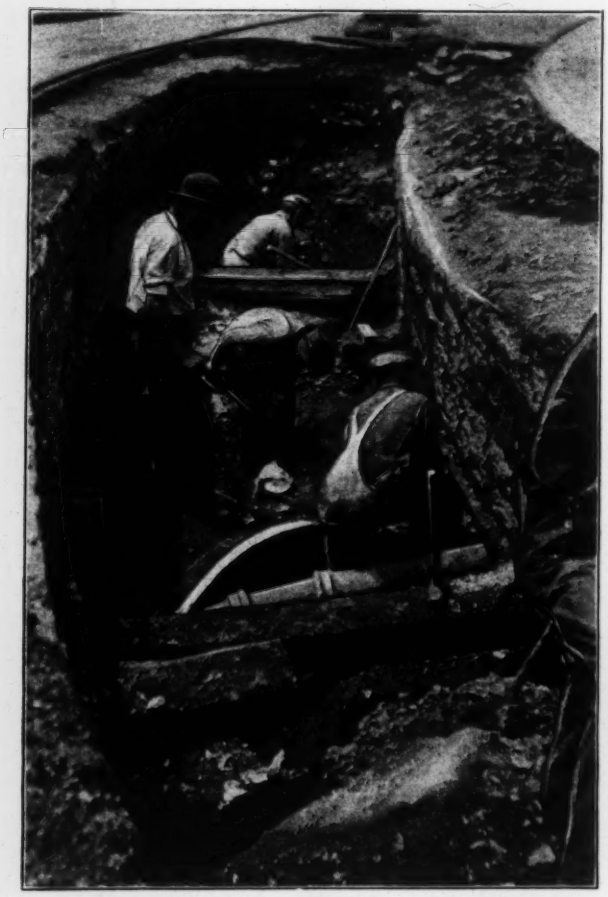
A 48-in. cast-iron water main, one of the four parallel mains forming the direct connection between the new Croton Aqueduct, which ends at 135th St., and Central Park Reservoir, New York City, broke at the corner of 109th St. and Manhattan Ave. during the early morning of June 4. The accompanying views emphasize the most remarkable feature of the break, which was the small amount of apparent damage done to the street and surrounding pavement. Although tons of water escaped, only a small part of it is said to have reached the surface.

It appears that the pipes at this point were laid through made ground, and that most of the escaping water was taken up in this fill, for there was no large sewer in the vicinity. It is therefore expected that the ground in the vicinity is pretty well honeycombed and resulting cave-ins will follow. There are evidences of this as far south as the entrance to Central Park at 100th St.

The street-railway tracks at the point where the break occurred are carried on parallel masonry piers or walls extending below the bottoms of the pipes, and the crossings over the pipes were bridged with rails, as shown in one of the accompanying views. There is no evidence as yet to show that the break was due to the vibration of the tracks.

The break occurred at the bottom of a bell connection, between the tracks, as the view shows. The pipe was under only about 20 lb. pressure. The pipe used was the standard adopted for the new Croton system about 1885. The pipe is 1¼ in. thick and the bell 1⅞ in. thick. The section of pipe line where the break occurred was laid about 1889 and put in service in July, 1890.

The superficial damage caused by the break was not extensive. The pavement at the street intersection cracked and sagged, in some places to a depth of 3 ft. below the normal elevation. Cellars of nearby apartment houses were flooded and their foundations threatened, so that the chief of the fire department ordered the occupants to be ready to vacate on short notice. The street-railway tracks were only temporarily out of commission.



BREAK IN 48-IN. WATER MAIN, 109TH ST. AND MANHATTAN AVE., NEW YORK CITY, JUNE 4

A Proposed State Department of Engineering

Consolidation of the public works of New York under one department is urged upon the State Constitutional Convention by the Albany Society of Civil Engineers and the Society of Engineers of Eastern New York. The former society adopted the following resolutions:

Resolved, that all engineering work in the state be consolidated under one department.

Resolved, that the department of the state having custody of engineering work be designated as State Department of Engineering.

Resolved, that the above department be under a single head, who shall be a civil engineer.

The Society of Engineers of Eastern New York at a recent meeting adopted the following resolutions prepared by a special committee on legislation:

1. The state engineer, either elective or appointive by the governor, should be retained as a constitutional officer with a term of office coincident with that of the governor in executive and responsible control of the Department of Engineering and Public Works.

2. A board of engineering and public works, composed of the state engineer, the attorney general and the comptroller, should be established as a constitutional board in place of the present Canal Board. The board of engineering and public works should have the power to pass on, adopt and approve all policies, undertakings, plans and contracts relating to the investigation, design, construction, maintenance and operation of the engineering and public works of the state, the state engineer to be the executive and responsible officer.

3. The state engineer should have control and direction of all the engineering and construction work of the state.

4. The department should be divided into suitable bureaus, including: Canals; highways; streams, waters and water power; bridges; standards of weights and measures and tests, and lands, buildings and survey.

Each bureau should be headed by a chief engineer, to be appointed and removable by the state engineer.

Rapid Transit for Cincinnati

A rapid-transit commission for the City of Cincinnati, Ohio, has been authorized by a legislative act just signed by the governor. When appointed by the mayor, a commission of five will select a chief engineer and build 14 mi. of city railways in tunnel, elevated and surface lines, at an estimated cost of $7,000,000, which is to be raised by a city bond issue. The project will follow the general lines suggested in a preliminary report made by Bion J. Arnold, of Chicago, in 1912, and developed in the 1914 report of F. B. Edwards and Ward Baldwin (see ENGINEERING NEWS, Mar. 25, 1915, p. 605). A $50,000 city bond issue has been spent on surveys, for which Prof. George F. Swain, of Cambridge, Mass., was consulting engineer.

Assessing Fire-Fighting Costs

The City Council of Cleveland, Ohio, has just passed an ordinance authorizing the city's bureau of fire prevention to bring suit against any owner of property for the recovery of the costs of fighting any fire due to the negligence or culpability of that owner or his agent. Such a law has been in force in New York City for some time, and two such suits have been brought and won by the city, thus apparently establishing its legality in New York. A similar law, signed by Governor Brumbaugh of Pennsylvania on May 6, applies to cities of the second class in that state. The essence of the law is as follows:

Where a fire originates on the premises occupied by any person, firm or corporation as a result of his or its criminal intent, design or wilful negligence, or where said person, firm or corporation has failed to comply with any law or ordinance made for the prevention of fire or the spreading thereof, such person, firm or corporation shall be liable in a civil action to the city for the payment of all costs and expenses of the fire departments incurred in the extinguishment of or any attempt to extinguish any fire originating as aforesaid. The amount of such costs and expenses shall be based upon the wages of the firemen and other officers for the time they were engaged, a reasonable amount as rental for the use of the apparatus and the cost of the water and other materials used, with an additional amount of 10 per cent. on the total amount as overhead charges.

Portland-Cement Production

The United States Geological Survey's final figures on portland-cement production in the United States in the calendar year 1914 show that 88,230,170 bbl. were produced, as compared with 92,097,131 bbl. in 1913, the record year. More important, however, is the statement that the shipments for the year were only 86,437,956 bbl., a falling off of 2.54 per cent. from the previous year, which brought about an increase of stock on hand of over a million barrels, the total at the beginning of 1915 being 12,893,863 bbl.

The 1914 production was distributed as follows: Lehigh district, 28 per cent.; east of Mississippi, exclusive of Lehigh district, 44 per cent.; west of Mississippi and east of the Rocky Mountains, 20 per cent.; Pacific Coast, 8 per cent. The average price per barrel at factory was $0.927, a decrease of 7.76 per cent. from the previous year.

A Steam Shovel Set Fire to Oil in a Pipe Line near Pen Argyl, Penn., on May 31, resulting in the destruction of the steam shovel (which was new), six box cars and the entire excavating outfit of Lathrop, Shea & Henwood, together with some property of the Lehigh & New England R.R. Co. The shovel was at work midway between Pen Argyl and Wind Gap, on the new yards which the Lehigh & New England R.R. recently started to build at a cost of nearly $1,000,000. The shovel accidentally struck and broke a pipe line belonging to the Tide Water Oil Co. The oil was ignited by hot coals from the firebox of the shovel. After some delay the oil supply was turned off at Tobyhanna, 40 mi. away. The fire is said to have continued until all the oil in the 40 mi. of piping was consumed.

The $27,000,000 Bond Issue for additional funds for the New York State Barge Canal noted in last week's issue was authorized by the recent legislature and is to be voted on at the next election.

Prizes for Denaturing Alcohol Processes — The Imperial Russian Ministry of Finance has just announced a competition looking toward the development of new methods of denaturing alcohol or toward perfecting the already existing processes. A first prize of 30,000 rubles ($15,450), a second prize of 15,000 rubles ($7725) and a third prize of 5000 rubles ($2575) have been offered. A number of other prizes are also announced. The competition closes Jan. 1, 1916. Further information in this country may be had by writing the Imperial Russian Embassy at Washington.

The Ottawa, Canada, Water-Supply Project described in "Engineering News," Jan. 7, 1915, p. 43, is at last going to be undertaken. On June 2 the Board of Water Commissioners decided to call immediately for tenders for the construction, to cost not more than $475,000. The plan proposes to use the Ottawa River unfiltered and to build a pumping station, with two units, at Lemieux Island. The water will be carried across the river to the city in a pipe line either on a bridge or in conduit. J. B. McRae, one of the formulaters of the plan, has been retained by the city to supervise the design and construction.

Consolidation of New York Suburban Railroads — The merger of the New York, Westchester & Boston Ry. with an allied company, the Westchester Northern R.R., was recently approved by the Public Service Commission for the first District. As shown in "Engineering News," June 5, 1913, the Westchester Northern is virtually a 30-mi. extension of the New York, Westchester & Boston, splitting at Pound Ridge to go to Brewster, N. Y., and Danbury, Conn. Five- and ten-year extensions of time were granted the Westchester Northern by the last state legislature for beginning and completing construction. The name of the New York, Westchester & Boston will be retained.

Patents on Caissons for Building Foundations owned by the Foundation Co. of New York City were sustained by the U. S. District Court, in a decision delivered on June 2 in the case of the Foundation Co. vs. the O'Rourke Engineering Construction Co. The patents sustained are two patents to D. E Moran (Nos. 759,388 and 759,389), dated May 10, 1904, and two patents to D. E. Moran and F. W. Doty (Nos. 828,761 and 828,861), issued Aug. 14, 1906. The owner of the patents filed disclaimers limiting the claims to pneumatic caissons of concrete used for building foundations. The defense, from the summary of the judge's decision, appears to have relied largely on citations from printed publications and prior patents. The court decision adjudged the patents to be valid and ordered an injunction against the defendant preventing further infringement and requiring an accounting of past profits from the use of the inventions. A notable feature in the patents sustained is the use of collapsible shafting which permits the shafting used in giving access to men and material to the working chamber to be removed and used over again.

Construction of the Ohio River Bridge at Metropolis, Ill., noted in "Engineering News" of June 3 as being postponed indefinitely, is to be pushed at once, as a result of changes in the condition of the financial world. The contract for the substructure has been let to the Union Bridge & Construction Co., of Kansas City, Mo., while the American Bridge Co. has the contract for the superstructure. There will be one span of 723 ft. c. to c. of piers, four of 556 ft., one of 304 ft. and one of 250 ft. The viaduct approaches will be 600 ft. long at the Kentucky end and 1600 ft. at the Illinois end. The bridge will have two tracks, 13 ft. c. to c. It is designed to carry on each track two engines of Cooper's E-90 loading followed by a train load of 7500 lb. per lin.ft. Its clear headway is to be 53 ft. above high water and 112 ft. at low water. The foundations will be sunk by pneumatic caissons. The bridge will be built by the Paducah & Illinois R.R., a subsidiary of the Chicago, Burlington & Quincy R.R. The Chief Engineer is C. H. Cartlidge, Bridge Engineer of the last-mentioned road. All plans are prepared in his office, and are submitted to Ralph Modjeski, who is the Consulting Engineer. The total cost for the bridge and approaches is estimated at about $3,500,000.

PERSONALS

Mr. Hal Moseley has recently been appointed City Engineer of Dallas, Tex.

Mr. John Gray has been appointed Superintendent in charge of the underground workings of the Twin Peaks Tunnel at San Francisco.

Mr. Frederick B. Lincoln, General Superintendent of the Erie R.R., with office at New York, has been promoted to the office of General Manager.

Mr. John Dwyer has been appointed Superintendent of Maintenance-of-Way of the Norfolk Southern R.R., with headquarters at Norfolk, Va.

Mr. M. A. Mulligan has been appointed Superintendent of the New York division of the Lehigh Valley R.R. Co., to succeed the late M. C. Roach.

Admiral Robert Stanislaus Griffin, Engineer-in-Chief of the U. S. Navy, on June 2 received the degree of Doctor of Science from Columbia University, New York City.

Mr. Myron J. Bigelow, formerly Mechanical Engineer of the Molyneux Mailing Machines Co., Buffalo, N. Y., has opened an office as consulting engineer at 47 Hawthorn Ave., Akron, Ohio.

Mr. H. R. Carpenter has been made Assistant Chief Engineer of the Missouri Pacific-Iron Mountain Ry. System, to succeed Mr. C. E. Smith, resigned. His headquarters will be at St. Louis.

Mr. A. F. Dorley, Principal Assistant Engineer of the Missouri Pacific-Iron Mountain System, has been made Engineer of Maintenance-of-Way of the Eastern district, with headquarters at St. Louis.

Dr. G. Klingenberg, a German engineer well known in this country, Director of the Allgemeine Elektricitäts Gesellschaft, of Berlin, Germany, has been decorated with the Order of the Iron Cross for his services in the field.

Prof. Robert L. Sackett, Assoc. M. Am. Soc. C. E., who for the last eight years has been Professor of Sanitary and Hydraulic Engineering of Purdue University, has been appointed Dean of the Engineering School of Pennsylvania State College.

Mr. A. E. Stevens has been appointed General Superintendent of the Eastern division of the Canadian Pacific Ry., with headquarters at Montreal, to succeed Mr. George Hodge, recently appointed Assistant to the General Manager at Montreal.

Mr. George H. Biles, recently Engineer of Maintenance, Pennsylvania State Highway Department, has been appointed Second Deputy State Highway Commissioner of Pennsylvania, to fill the vacancy caused by the resignation of Mr. Edward A. Jones, of Scranton.

Mr. John Ernest Lloyd, Assistant Division Engineer at Garrett, Ind., of the Baltimore & Ohio R.R., has been appointed Division Engineer of the Cleveland division, to succeed Mr. A. A. Jackson, who is retiring from railroad work and will reside in Baltimore.

Mr. P. F. Patton, of Hendersonville, N. C., has been selected by the Greenville Highway Commission as Supervising Engineer for the road work which is to be done in that county with the proceeds of a $950,000 bond issue. Mr. Patton is Supervisor of Henderson County.

Mr. Paul Lindholm, Engineer of Highways of Copenhagen, Denmark, has been awarded the Traveling Fellowship of the American Scandinavian Foundation for 1915-16. Mr. Lindholm will devote the year to graduate work in highway engineering at Columbia University, New York City.

Mr. D. L. Reaburn, M. Am. Soc. C. E., who for several years was connected with the construction of the Los Angeles Aqueduct, and more recently was Locating Engineer with the Alaskan Engineering Commission, has been appointed Superintendent of the Rainier National Park, in the State of Washington.

Mr. Charles U. Powell, who for the past 15 years has been a member of the New York City civil engineering staff, has been appointed Chief Engineer of the Queens Topographical Bureau, to succeed Mr. Clifford B. Moore, who was made Consulting Engineer of the Borough of Queens to fill the vacancy caused by the death of J. Foster Crowell. Mr. Powell will receive a salary of $6000.

Mr. Gustave R. Tuska, M. Am. Soc. C. E., Consulting Engineer, New York City, who for some years has been acting as Consulting Engineer to various garbage-, refuse- and waste-disposal plants in this country and abroad, has been appointed Lecturer in Municipal Waste Disposal at Columbia University, New York City. Mr. Tuska will deliver a course of lectures on the subject at the university during the coming year.

Mr. C. E. Smith, M. Am. Soc. C. E., recently Assistant Chief Engineer of the Missouri Pacific-Iron Mountain Ry. System, has opened an office as consulting engineer at 2075 Railway Exchange Building, St. Louis, Mo. Mr. Smith will engage in general railway and municipal engineering practice, with particular reference to terminal problems, elimination of grade crossings, bridges and miscellaneous structures, and valuations.

Mr. Roy B. White, Superintendent at Indianapolis of the Cincinnati, Hamilton & Dayton Ry., has resigned his position with that road and entered the service of the Baltimore & Ohio Southwestern R.R., as Superintendent of the Illinois division. His headquarters will be at Flora, Ill. Announcement has also been made that Mr. M. V. Hynes, Superintendent of the Wellston & Delphos division of the Cincinnati, Hamilton & Dayton, will succeed Mr. White at Indianapolis.

Mr. Herbert M. Wilson, M. Am. Soc. C. E., engineer in charge of the Pittsburgh Experiment Station of the United States Bureau of Mines, has resigned from the Government service to become the director of a newly formed organization to be known as the Coal Mine Insurance Association. Mr. Wilson was closely associated with Director Joseph A. Holmes in the inception and development of the Bureau of Mines. With its creation he became engineer in charge of the Pittsburgh station, a position which he has held ever since. Mr. Wilson was educated in mining as well as in civil engineering, being graduated from the School of Mines, Columbia University, New York. The Coal Mine Insurance Association, of which Mr. Wilson is to be the director, is a combination of 10 American and British insurance companies that have associated themselves for the joint underwriting of coal-mine accident insurance.

OBITUARY

Hugh Roloson Scott, for 32 years in the employ of the Western Maryland Ry., died on May 31 at his home in Arlington, Md., from a complication of diseases. He was 61 years of age.

Philip P. Mirtz, for ten years Mechanical Engineer of the Lake Shore & Michigan Southern Ry., at Cleveland, died at his home in New York on May 11, from pneumonia. When the Lake Shore & Michigan Southern Ry. was merged with the New York Central lines last winter Mr. Mirtz was transferred to New York, where he was connected with the office of the chief mechanical engineer.

John McKechney, one of the old contractors of Chicago, died in that city on May 25, at the age of 70. He was born in Quebec, but had lived in Chicago since 1864. The firm of Hill, McKechney & Co. did a large amount of railway construction work. Later the firm name was changed to Weir, McKechney & Co., which built parts of the Chicago drainage canal and the Northwest land tunnel of the city's water-supply system. Mr. McKechney retired from business in 1908.

Herbert W. Cowan, Chief Engineer of the Colorado & Southern Ry., died recently at his home in Denver at 52 years of age. Mr. Cowan was born at Bath, Me., and was a graduate of the Worcester Polytechnic Institute. He entered the railroad service in 1886 as topographer and draftsman with the Winona, Alma & Northern Ry. In 1894 he became Resident Engineer at Denver of the Union Pacific, Denver & Gulf and Denver, Leadville & Gunnison Ry. Four years later he was made Chief Engineer of the Colorado & Southern Ry., successor to those roads, and in 1907 was made also Consulting Engineer of the system.

Morton L. Tower, M. Am. Soc. C. E., Assistant Engineer, United States Engineer Department, who had been in local charge of the reconstruction of the Government jetties at the entrance to Humboldt Bay, California, died on Apr. 17 from injuries received two days previously, when a motor car on which he was traveling to the quarry where rock for the jetties is obtained left the track on a trestle and threw him to the bottom of a ravine. Mr. Tower had been in the em-

ploy of the United States Engineer Department since 1889, during which time he had been engaged principally on river and harbor and fortification work at various points on the California and Oregon coasts. The reconstruction of the Humboldt jetties, of which he had been in immediate charge since the latter part of 1910, involves an expenditure of about $1,750,000. Mr. Tower was largely responsible for the design of the work and for the novel methods of construction which are being successfully used.

ENGINEERING SOCIETIES

COMING MEETINGS

MASTER CAR BUILDERS' ASSOCIATION.
June 14-16. Annual convention in Atlantic City. Secy., Jos. M. Taylor, Karpen Bldg., Chicago.

OHIO SOCIETY OF MECHANICAL, ELECTRICAL AND STEAM ENGINEERS.
June 17-18. Semi-annual meeting at Toledo. Secy., Frank E. Sanborn, Ohio State University, Columbus.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.
June 22-25. Annual meeting at Iowa State College, Ames, Iowa. Secy., F. L. Bishop, University of Pittsburgh, Pittsburgh, Penn.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
June 22-25. Summer meeting at Buffalo, N. Y. Secy., Calvin W. Rice, 29 W. 39th St., New York City.

AMERICAN SOCIETY FOR TESTING MATERIALS.
June 22-26. Annual meeting in Atlantic City. Secy., Edgar Marburg, University of Pennsylvania, Philadelphia, Penn.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS.
Aug. 16-18 and 25-28. Annual meeting in Los Angeles, Calif., Aug. 16-18; in San Francisco, Aug. 25-28. Secy., J. C. Olsen, Cooper Union, New York City.

AMERICAN ASSOCIATION OF RAILROAD SUPERINTENDENTS.
Aug. 19-21. Annual Convention in San Francisco. Secy. E. H. Harman, Room 101, Union Station, St. Louis, Mo.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
Sept. 16-18. Annual meeting in San Francisco. Secy., Chas. Warren Hunt, 220 W. 57th St., New York City.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
Sept. 16-18. Annual meeting in San Francisco. Secy., Calvin W. Rice, 29 W. 39th St., New York City.

AMERICAN INSTITUTE OF MINING ENGINEERS.
Sept. 16-18. Annual meeting in San Francisco. Secy., Bradley Stoughton, 29 W. 39th St., New York City.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.
Sept. 16-18. Annual meeting in San Francisco. Secy., F. L. Hutchinson, 29 W. 39th St., New York City.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.
Sept. 16-18. Annual meeting in San Francisco. Secy., J. J. Blackmore, 29 W. 39th St., New York City.

AMERICAN ELECTROCHEMICAL SOCIETY.
Sept. 16-18. Annual meeting in San Francisco. Secy., J. W. Richards, Lehigh University, South Bethlehem, Penn.

INTERNATIONAL ENGINEERING CONGRESS.
Sept. 20-25. In San Francisco.

American Peat Society—The ninth annual meeting of the American Peat Society will be held in Detroit, Mich., Sept. 20-22. The secretary is Julius Bordollo, Kingsbridge, N. Y.

Ohio Society of Mechanical, Electrical and Steam Engineers—The semi-annual meeting will be held in Toledo, Ohio, June 17 and 18. The annual meeting will be held Nov. 18 and 19, 1915. The place is yet to be determined. The secretary is Frank E. Sanborn, Columbus, Ohio.

Western Railway Club—At the annual meeting held at Chicago in May officers were elected as follows: President, H. H. Harvey (C. B. & Q. R.R.), Chicago; vice-president, W. E. Dunham (C. & N. W. Ry.), Winona, Minn.; A. R. Kipp (M., St. P. & S. S. M. Ry), Fond du Lac, Wis.; secretary, Joseph W. Taylor, 1112 Karpen Building, Chicago.

Special Libraries Association—The annual meeting will be held in Berkeley, Calif., June 7 and 8. The program, just issued, contains eight papers and two committee reports. Guy E. Marion, who has been secretary of the association since March, 1910, handed in his resignation to take effect on June 3, 1915. During his term of office the Association has grown from about 50 members to more than 350.

New England Water Works Association—A joint field day and excursion will be held June 16 by the New England Water Works Association and the Boston Society of Civil Engineers. One of the features will be a baseball game between the two societies. A business meeting of the New England Water Works Association will be held immediately after the dinner, which will take place at 1 p.m.

Missouri Public Utilities Association—The ninth annual convention of the Missouri Public Utilities Association was held May 27-30 on board the Steamer "Quincy" from St. Louis. A 24-hr. trip was made on the Mississippi, Ohio, Cumberland and Tennessee rivers. The Mississippi was at very high stage, being out of banks in a number of places. The attendance was about 200, of whom 75 were ladies.

New York Electrical Society—The annual meeting will be held at the Hotel Martinique, New York City, on Tuesday, June 15, at 8.30 p.m. Following are the official nominations: For President, Elmer A. Sperry; vice-presidents, George W. Elliott, S. N. Castle and Bernhard Hoffman; secretary, George H. Guy; treasurer, Henry J. Hoeltge. A smoker and entertainment will follow the business session.

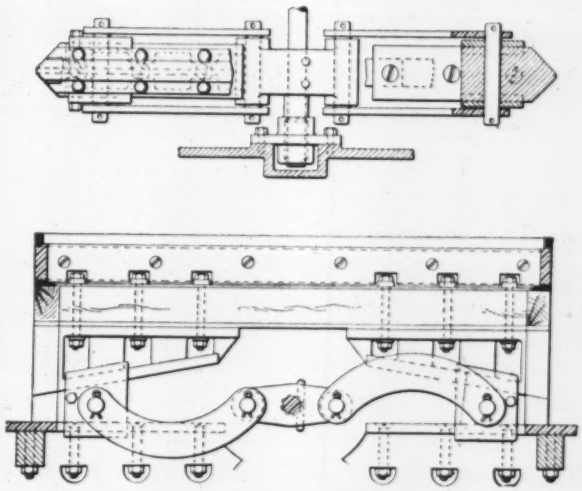
Building Inspectors' Conference—The conference was called to order May 14 by R. P. Miller, about 30 building officials being in attendance. Mr. Miller was chosen temporary chairman and Sidney J. Williams, secretary. These two were later elected permanent chairman and secretary respectively, with power to arrange the details of organization and of the next meeting, which will be held in some Western city, probably during the winter or early spring of 1916. The address of the secretary is care of the Industrial Commission, Madison, Wis.

Colorado Association of Members of the American Society of Civil Engineers—The annual meeting of this association will be held in Denver, Colo., on June 12 at the Albany Hotel. Frederick H. Brandenburg, district forecaster of the U. S. Weather Bureau, will speak on the work done and methods used by the Bureau to determine the rainfall of Colorado, precipitation in high altitudes, snowfall and water content as a basis for estimating the stream discharge, flood data, temperature, wind, and other climatic conditions of Colorado. There will be no meeting of the association during July and August, but the regular Wednesday luncheons will be continued.

Appliances and Materials

Noiseless Railway Crossings

A novel design of shockless and noiseless railway-track crossing has been designed by the Cobb Shockless Crossing Co., of Los Angeles, the construction of which is indicated in the accompanying sketch. The scheme is simple, consisting of depressing the rails not in use and leaving the others at grade to give a continuous through-rail surface. There are

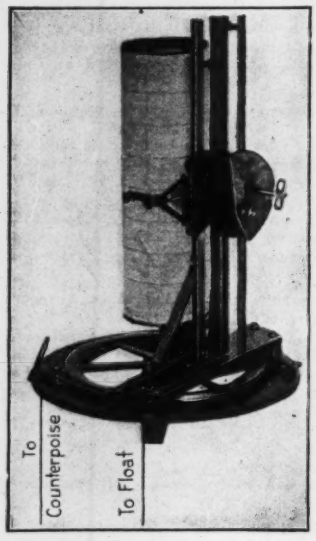


RAIL OF NOISELESS CROSSING

four rail ends at each of the four intersections of a single-track crossing, the two approaching rails being fixed and the inner ones being depressable. All four ends are mitered to give an interlocking joint. Each movable rail is bolted to a wood stringer, on the under side of which is a plate and two wedge castings. The wedges rest on a pair of smaller wedges moving in wrought-iron guides on the box casing. Curved links connect to a double-arm crank on a shaft. A half revolution clockwise lowers one pair of rails and the return of the shaft raises them. The two pairs of rails at each crossing are interlocked so that only one can be lowered at a time. The operating shaft may be power or hand operated. Some of these crossings have been used by the Pacific Electric Ry. for several months with good results.

Recording Water-Level Gage

The line of water-stage recorders designed by J. C. Stevens has been increased by the addition of a simple and inexpensive eight-day recording gage intended particularly for service as a meter on irrigation canals, laterals, etc. As shown in the accompanying view, there is a vertical drum carrying a paper chart and revolved to correspond with the changes in water level. Parallel with the drum is a rack and track on which the pencil carriage travels, moving from top to bottom in eight days under the control of a clock which is on the carriage. On the main-spring shaft is a gear meshing with the rack; as the spring unwinds, the clock and pencil descend at a rate of 1¼ in. per day, the weight of the carriage helping the spring. The smallest vertical-scale chart division is 2 hr., but time can be read to 15 min. In the normal chart the smallest horizontal-scale division represents 0.02 ft. The charts are prepared as cylinders, which are slipped on the drum, the latter being split and held together with springs allowing $\frac{1}{32}$-in. reduction of diameter. Charts are cut in removal.



EIGHT-DAY RECORDING WATER GAGE

The drum is turned by a float in a stilling box, one revolution corresponding to 2-ft. change of water level. But by using a single-sheave pulley on the float and a two-part cable to the drum one revolution corresponds to 1-ft. change of level, and then each horizontal chart division represents 0.01 ft. While the instrument is particularly intended to record small fluctuations, yet the record is intelligible for several revolutions of the drum and any level change up to 10 ft. or over.

The gage sells for from $42.50 to $55, depending on the number purchased. The manufacturers are Leopold, Voelpel & Co., 107 E. 70th St. North, Portland, Ore.

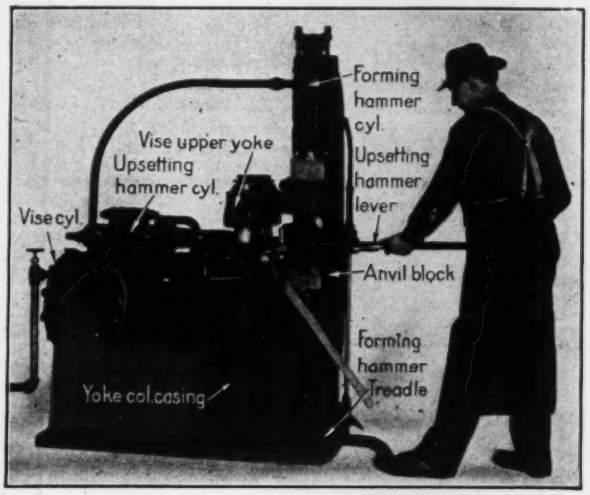
* * *

Drill Sharpener With Air Hammers

The new machine for making and sharpening drill bits shown in the accompanying view as manufactured by the Sullivan Machinery Co., of Chicago, operates entirely by compressed air. A heavy box frame supports the horizontal upsetting hammer and an upright carries the vertical forming hammer. It is 5x2½ ft. in plan and 6 ft. high, and weighs 4000 lb.

The steel is held by an air-thrown vise just in front of the horizontal hammer. It has a pair of massive yokes and two heavy steel columns. The yoke above and the anvil below are recessed to receive the removable clamping dies. The vise is operated by a 12-in. horizontal cylinder in the rear end of the frame, the piston working a link and toggle on the lower yoke and columns to drag down the upper yoke. The two hammers are rock-drill cylinders. The horizontal hammer has a floating piston and a loose distance piece, upset on the end inside the cylinder to receive the blows of the piston and blank at the front end to receive a loose dolly. The vertical hammer has a regular drill piston and piston rod, to the end of which is fitted a guide-block, which carries the upper of two square swaging dies. The lower die is keyed to an anvil block on the frame. The vertical hammer and die stand normally raised (by a spring and pin in the control valve). This hammer is worked by a foot treadle. The vise and upsetting hammer are controlled by the same hand lever. Lubrication is practically automatic, and automatic jets of exhaust air blow the work surfaces clean of scale and dirt.

In making new bits from blank stock the steel is heated and closed in the clamping dies. When the vise is shut, further depression of the hand lever admits air to the horizontal hammer, and a few blows from the dolly upset the steel slightly. The operator then raises the lever, stopping the hammer and opening the vise. He then starts the vertical hammer with his foot, and this makes the wings or ears of the bit. A positive stop prevents the operator from accidentally working the vertical hammer while the steel is being handled in the horizontal members. The bit is finished with two or three alternate operations of the upsetting and forming hammers and in one heat—in 50 or 60 sec. A variety of small



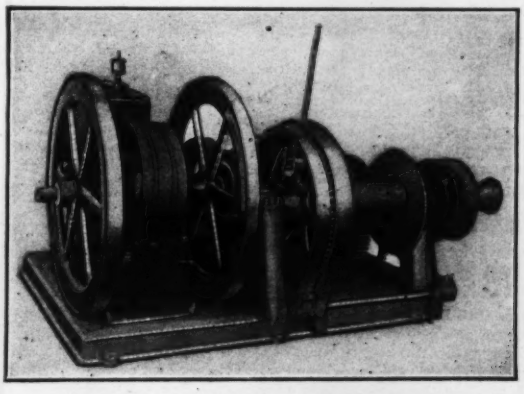
COMPRESSED-AIR DRILL SHARPENER

forging can also be done with the machine. The long inclined lever below the vise lever is for pulling pins out of hollow-steel shanks (pins driven in to reopen the hole after this has been closed in upsetting the lugs or collar).

* * *

Contractor's Gasoline Hoist

A reversible hoist driven by a gasoline engine is now being put out by the O. K. Clutch & Machinery Co., of Columbia, Penn. The hoist and engine are intended for building construction, logging and miscellaneous hoisting and hauling. The hoist is of a design having an extended bedplate for any engine, motor or belt drive desired. On an extension of the drum shaft is a winch head; on the other end is a brake-wheel with ratchet and pawl to hold any load within the lifting capacity of the hoist. The forward shaft is geared to the drive and connected through a friction clutch and pinion to the main drum gear. The reverse shaft is geared to the forward shaft and also drives the drum gear through a



CONTRACTOR'S GASOLINE-ENGINE HOIST

clutch and pinion. With a gasoline-engine unit the forward and reverse shafts and engine revolve continuously and one clutch or the other is thrown in as needed.

The engine has a water-jacketed cylinder and hopper cooler, wide babbited main bearings, phosphor-bronze connecting-rod bearings, magneto and battery ignition, etc. The floor space occupied is 48x64 in.; 4-, 6-, and 8-hp. engines are used, and the net weights complete run from 2500 to 3500 lb. The lift ranges from 700 to 2250 lb. for these engine equipments, with 150- and 100-ft. hoisting speeds and 5:1, 7:1 nd 10:1 gear ratios.